FM 6-161

DEPARTMENT OF THE ARMY FIELD MANUAL

RADAR SET AN/MPQ-4A

HEADQUARTERS, DEPARTMENT OF THE ARMY

JUNE 1969

TAGO 20029A

$ 3.95

FIELD MANUAL
No. 6–161

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *26 June 1969.*

RADAR SET AN/MPQ–4A

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*This manual supersedes FM 6–161, 17 February 1965, and chapter 8, FM 6–125, 23 April 1963.

CHAPTER 1
GENERAL

1. Purpose and Scope

a. This manual is a guide for personnel responsible for employing and operating the radar set AN/MPQ–4A. The manual covers the equipment and operating procedures to be used by radar sections in weapon location and radar gunnery missions, decontamination and destruction of equipment, safety precautions, and section training.

b. The material presented herein is applicable, without modification, to both nuclear and nonnuclear warfare.

2. Changes and Comments

Users of this manual are encouraged to submit recommended changes or comments to improve the manual. Comments should be keyed to the specific page, paragraph, and line of the text in which the change is recommended. Reasons should be provided for each comment to insure understanding and complete evaluation. Comments should be prepared using DA Form 2028 (Recommended Changes to Publications) and forwarded direct to the Commandant U.S. Army Field Artillery School, ATTN: AKPSIAS–PL–FM, Fort Sill, Oklahoma 73503.

3. References

Related publications are listed in the appendix.

CHAPTER 2
EQUIPMENT

4. Description

a. The radar set AN/MPQ–4A is a mobile, pulse-modulated, nontracking, dual-beam, beam-intercept radar. It can be used to locate mortars and other high-trajectory weapons, observe registrations, adjust fire, and detect and locate moving targets. When modified, it may be used to locate lower-trajectory weapons such as howitzers. The complete set, with its associated equipment, is contained in two trailers—the radar-trailer (fig. 1) and the power unit trailer (fig. 2).

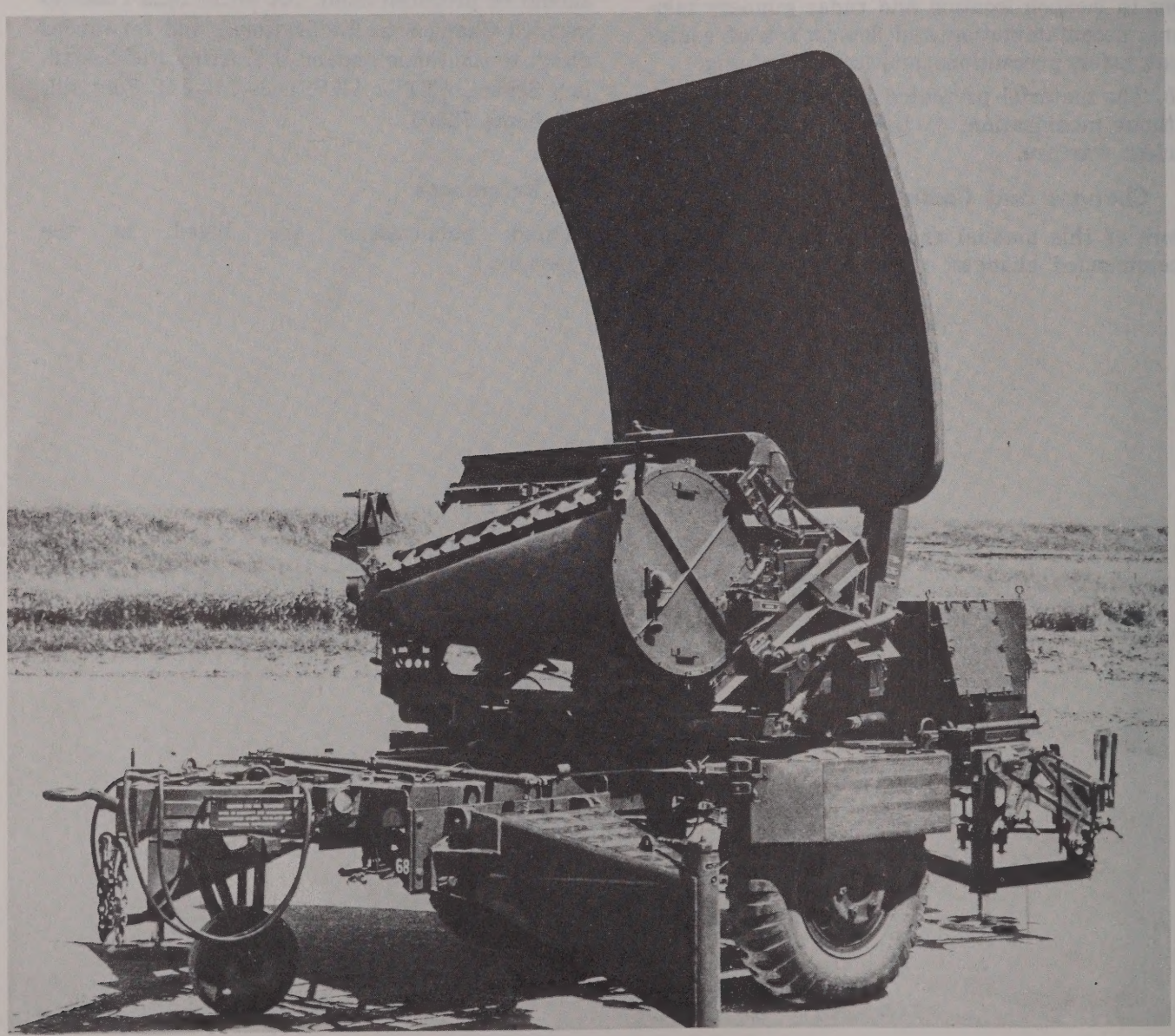

Figure 1. Radar trailer.

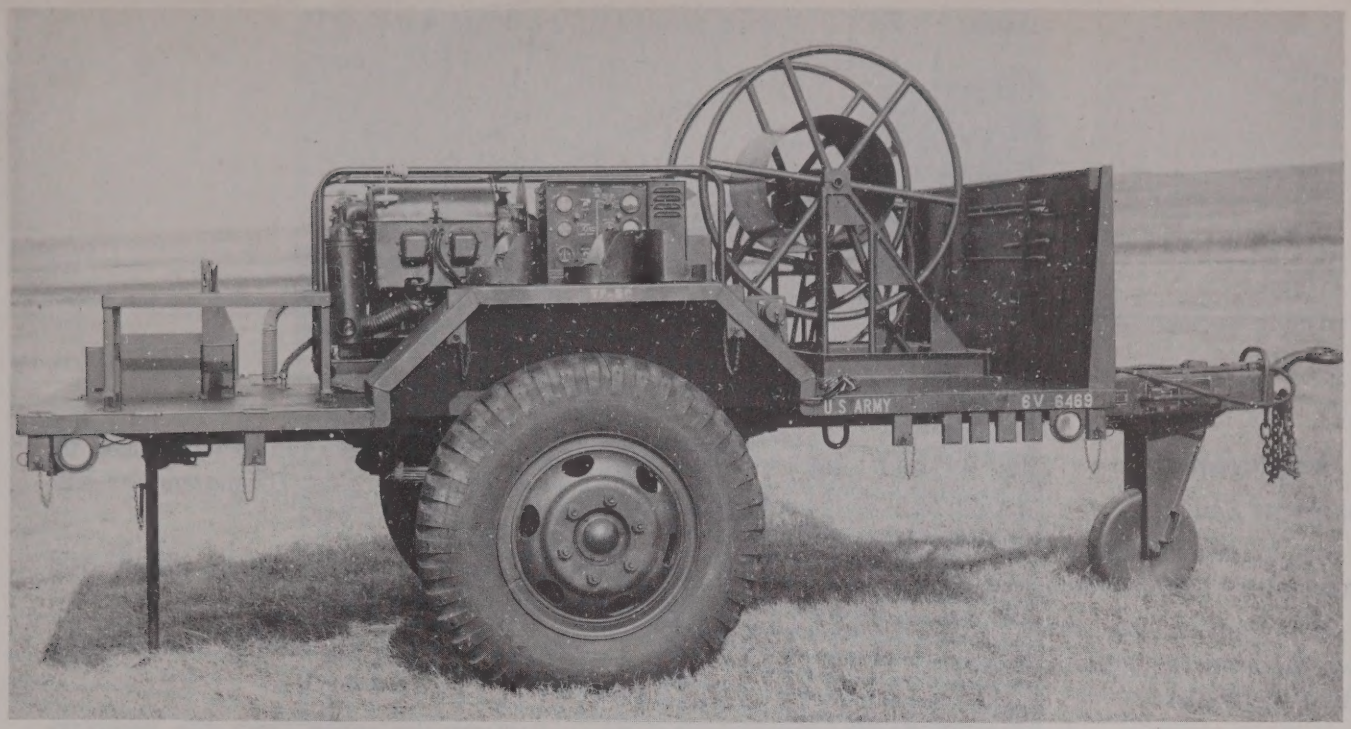

Figure 2. Generator set, gasoline-engine-driven, trailer-mounted, PU–304C/MPQ–4.

b. The radar set consists of a radar trailer, an antenna group, a receiver-transmitter group, a control-indicator group, a dehydrator, and a power unit.

c. The antenna group, receiver-transmitter group, dehydrator, and control-indicator group are mounted on the radar trailer (fig. 1). This trailer provides a means of transportation and a platform for operation. The control-indicator group may be removed for remote operation and emplaced up to 150 feet away.

d. The generator set, gasoline-engine-driven, trailer-mounted PU–304C/MPQ–4 (fig. 2) consists of a 1½-ton cargo trailer M105A2 on which a power unit generator, 400-hertz, 10-kw, military standard model HF–10–MD is mounted. The power unit provides the 120/208-volt, 400-hertz, 3-phase power required for operation of the radar. The power unit trailer is also used to transport the operators' shelter, the interconnecting cables, the spare parts, the control unit stand, and the seat support.

5. Performance Data

Pertinent performance data for the radar set are as follows:

a. Sector coverage: 445 mils.

b. Range:

(1) *Maximum:* 10,000 meters.

(2) *Minimum:* 170 meters.

c. Azimuth coverage: 6,400 mils.

d. Elevation coverage: —100 to +200 mils.

e. Rounds required for location: One.

f. Accuracy of location: 0 to 50 meters.

g. Weight: 6,250 pounds.

h. Mobility: Comparable to that of a towed 155-mm howitzer.

6. Technical Characteristics

Technical characteristics of the radar are as follows:

a. Frequency: 16,000 megahertz (MHz) (Ku band).

b. Pulse repetition frequency (PRF): 8,600 pulses per second (PPS).

c. Pulse width: 0.25 microsecond.

d. Peak transmitted power: 50,000 watts.

e. Intermediate frequency (IF): 30 megahertz.

f. Power requirements: 120/208-volt, 400-hertz, 3-phase, 5-kilowatt (kw).

CHAPTER 3
PREPARATION FOR ACTION

Section I. EMPLACEMENT AND MARCH ORDER

7. Emplacement

a. Radar Set.

(1) Locate the radar trailer in a suitable position. Set the trailer handbrakes.

(2) Remove the three outrigger pads and place them on the ground to the left, right, and rear of the trailer.

Caution: Three men are required to lower the rear outrigger arm, one at each end and one at the center post. The rear outrigger must be lowered before the radar trailer is uncoupled from the prime mover. This prevents the radar trailer from pitching backward.

(3) Loosen the lower transit locking screws (fig. 3) and release and lower the rear outrigger arm. Secure the rear outrigger arm with the front operational locking screws (fig. 4). Release the upper transit locking screws (fig. 3) and loosen the pivot screws. Rotate the outrigger arm to the upright position and secure it with the rear operational locking screws (fig. 4). Tighten the pivot screws.

(4) Loosen the jack locking screws on the support brace (fig. 3) and rotate the brace to the forward position. Secure the support brace with the support brace locking screw. Tighten the jack locking screws.

(5) Center the rear outrigger pad (fig. 4) directly under the jackscrew.

(6) Lower the landing wheel and uncouple the radar trailer from the prime mover (fig. 6).

(7) Lower the side outriggers and secure them with the locking screws (fig. 5 and 6).

(8) Center the right and left outrigger pads under the jackscrews. Lower the jackscrews until they contact the outrigger pads. Disengage the reflector support arm from its stowed position (fig. 7).

(9) Rotate both wheel fenders outward by disengaging the locking pins. Disengage the azimuth stowlock.

(10) Release the reflector clamps (fig. 8) and pivot them clear of the reflector.

(11) Raise the reflector. Secure it in position with the locking screws (fig. 9).

(12) Remove the cover from the receiver-transmitter group.

(13) Level the radar.

(14) Open all vents.

(15) Remove the cover from the control-indicator group.

b. Generator Set.

(1) Position the generator within 100 feet of the radar control-indicator group. Set the handbrakes, lower the landing wheel and the support leg, and uncouple the trailer from the prime mover.

(2) Connect the power cable between the power unit and the control-indicator group. If remote operation is desired, connect the control cable between the control-indicator group and the radar trailer.

Caution: The guide keys in the cable head are easily sheared. Extreme care must be exercised to prevent shearing the guide keys and to preclude connecting the cable upside down.

(3) Emplace the ground stake.

(4) Attach gas hose to gas can.

(5) Attach flexible exhaust extension to exhaust pipe.

(6) Raise the canvas flaps around the trailer.

8. Installation of Operators' Shelter

The detailed procedure for installing the operators' shelter is given in paragraph 45*b*, TM

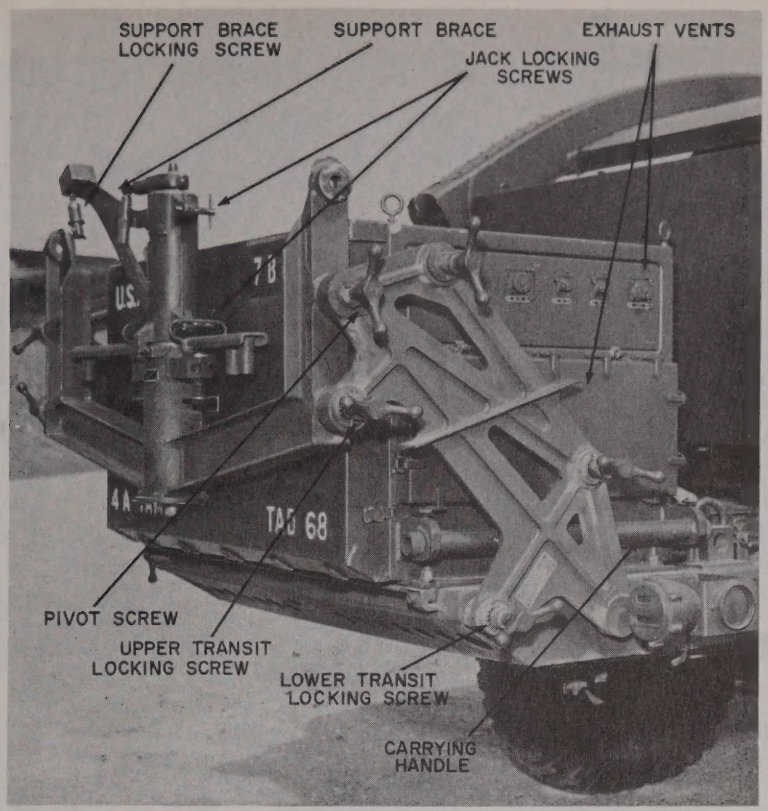

Figure 3. Rear outrigger arm in transit position.

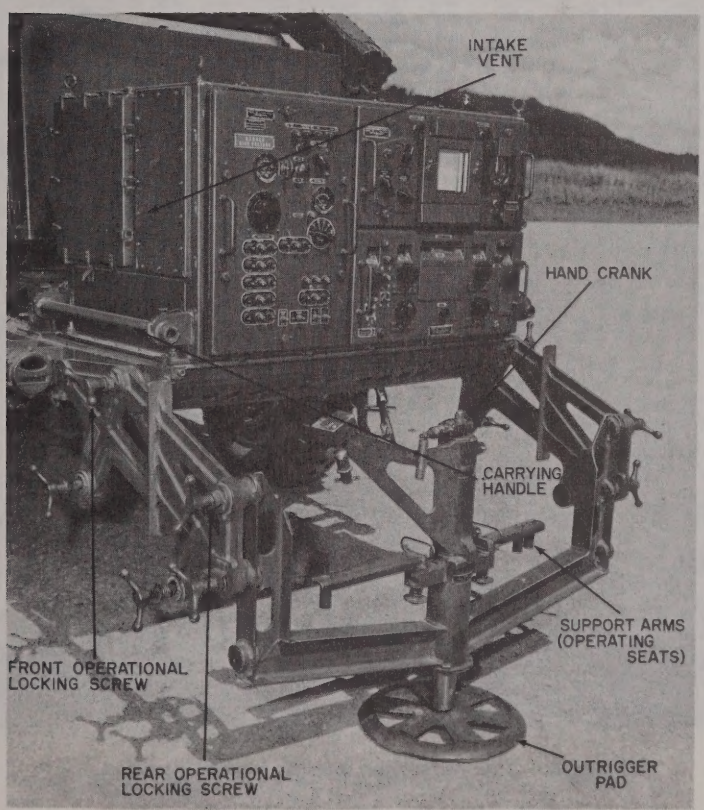

Figure 4. Rear outrigger arm in operational position.

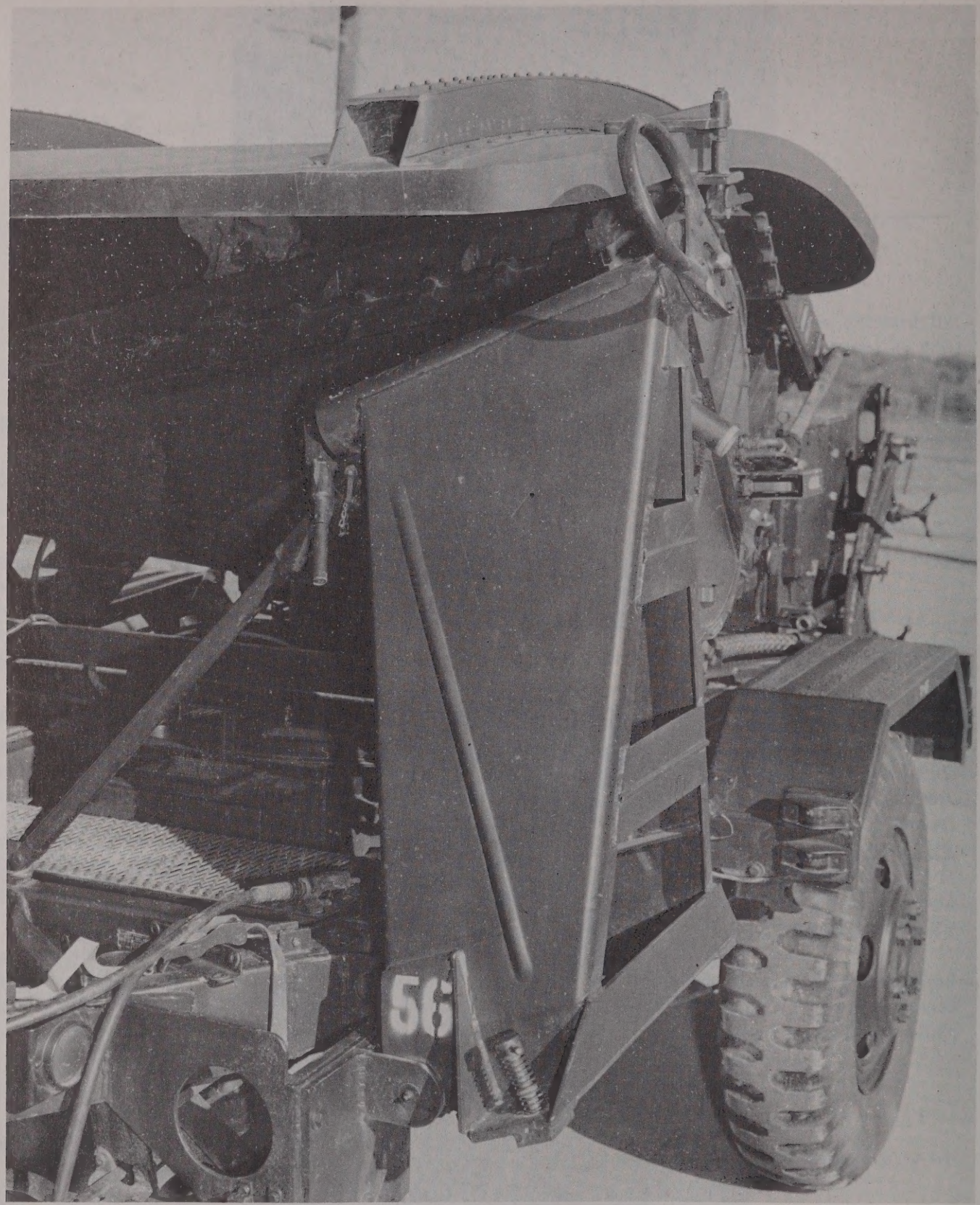

Figure 5. Side outrigger arm in transit position.

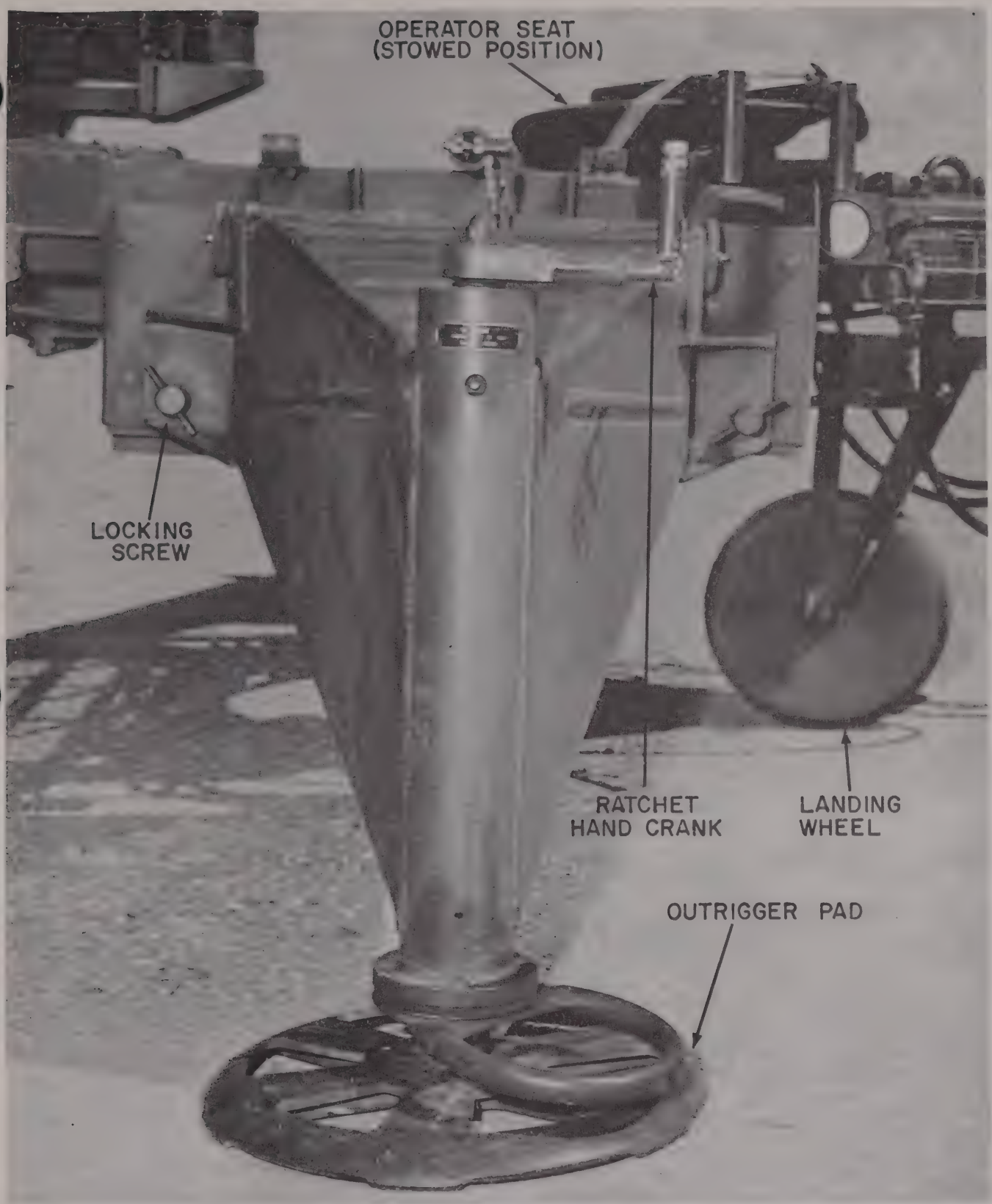

Figure 6. Side outrigger arm in operational position.

11–5840–208–10. The general configuration of the interior of the shelter is shown in figure 10.

9. March Order

a. *Radar Trailer.*

(1) Disassemble the shelter by performing, in reverse order, the procedure outlined in paragraph 45*b*, TM 11–5840–208–10.

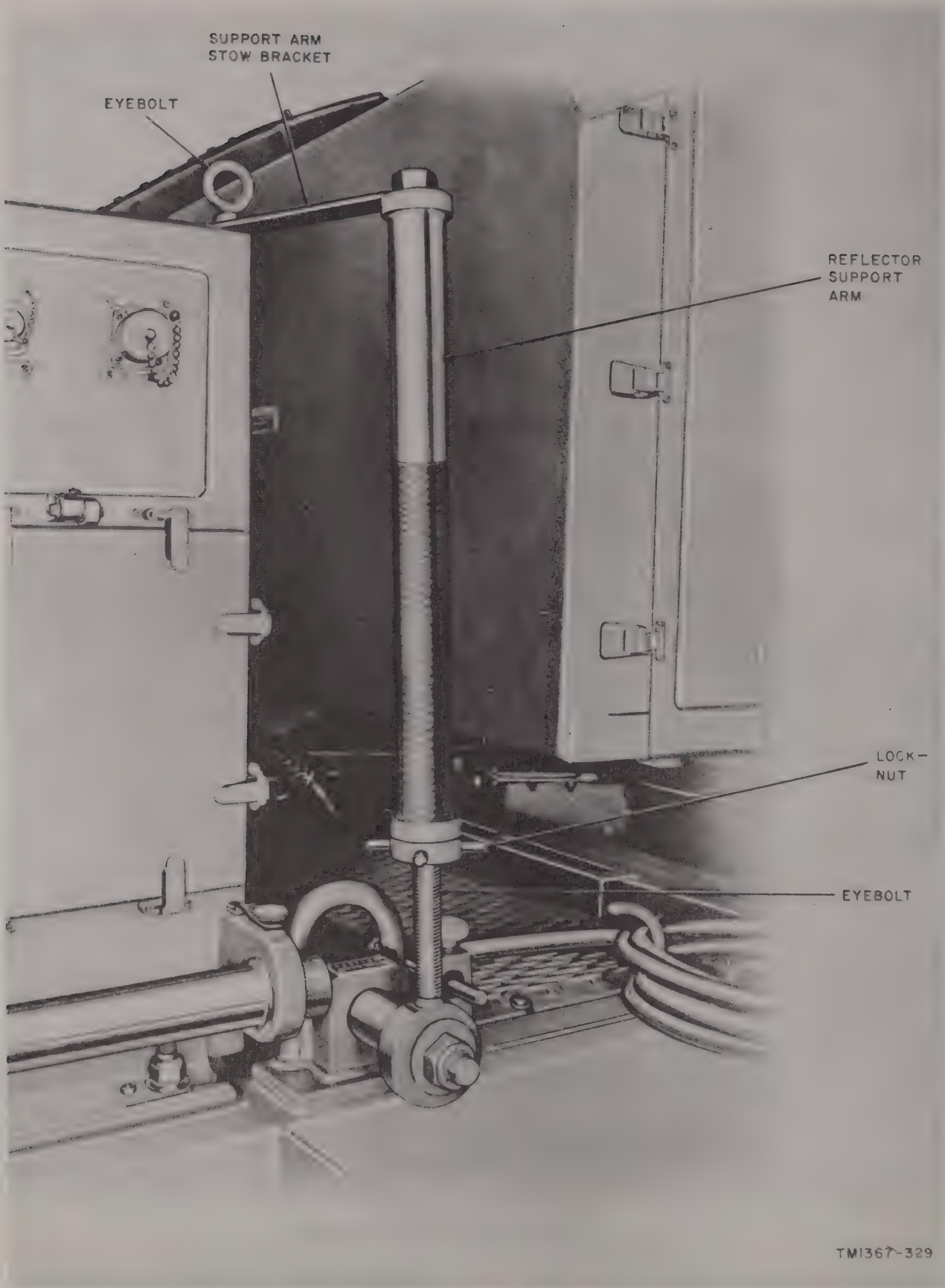

Figure 7. Reflector support arm in stowed position.

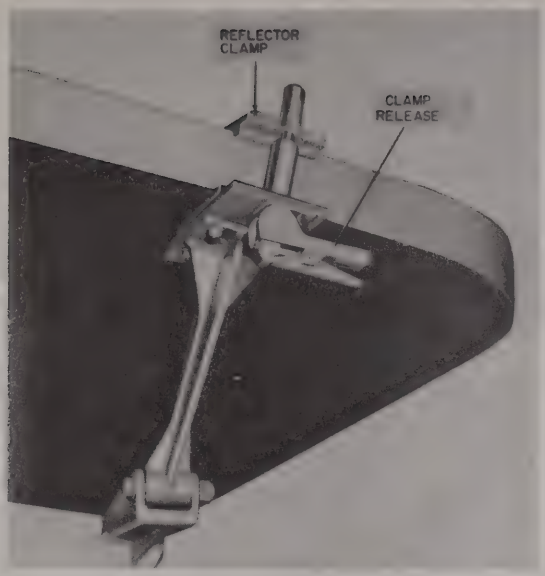

Figure 8. Reflector locking clamps.

(2) Elevate the antenna to approximately +175 mils.

(3) Engage the azimuth stowlock.

(4) Close all vents. Replace the covers on the control-indicator group and the receiver-transmitter group.

(5) Unlock the reflector locking screws. Lower the reflector into the traveling position and secure it with the reflector clamps.

(6) Place the fenders in the traveling position and secure them with the locking pins.

(7) Release the pressure from all jacks and place the jack pads on the traveling brackets.

(8) Release the locking screws on the side outriggers. Raise and secure the side outriggers to their retaining posts.

(9) Disconnect and reel in the cables.

(10) Couple the radar to the prime mover.

(11) Raise the landing wheel and release the handbrakes. Release the rear jack brace. Raise the rear outrigger arm.

(12) Place the reflector support arm in its transit position (fig. 11).

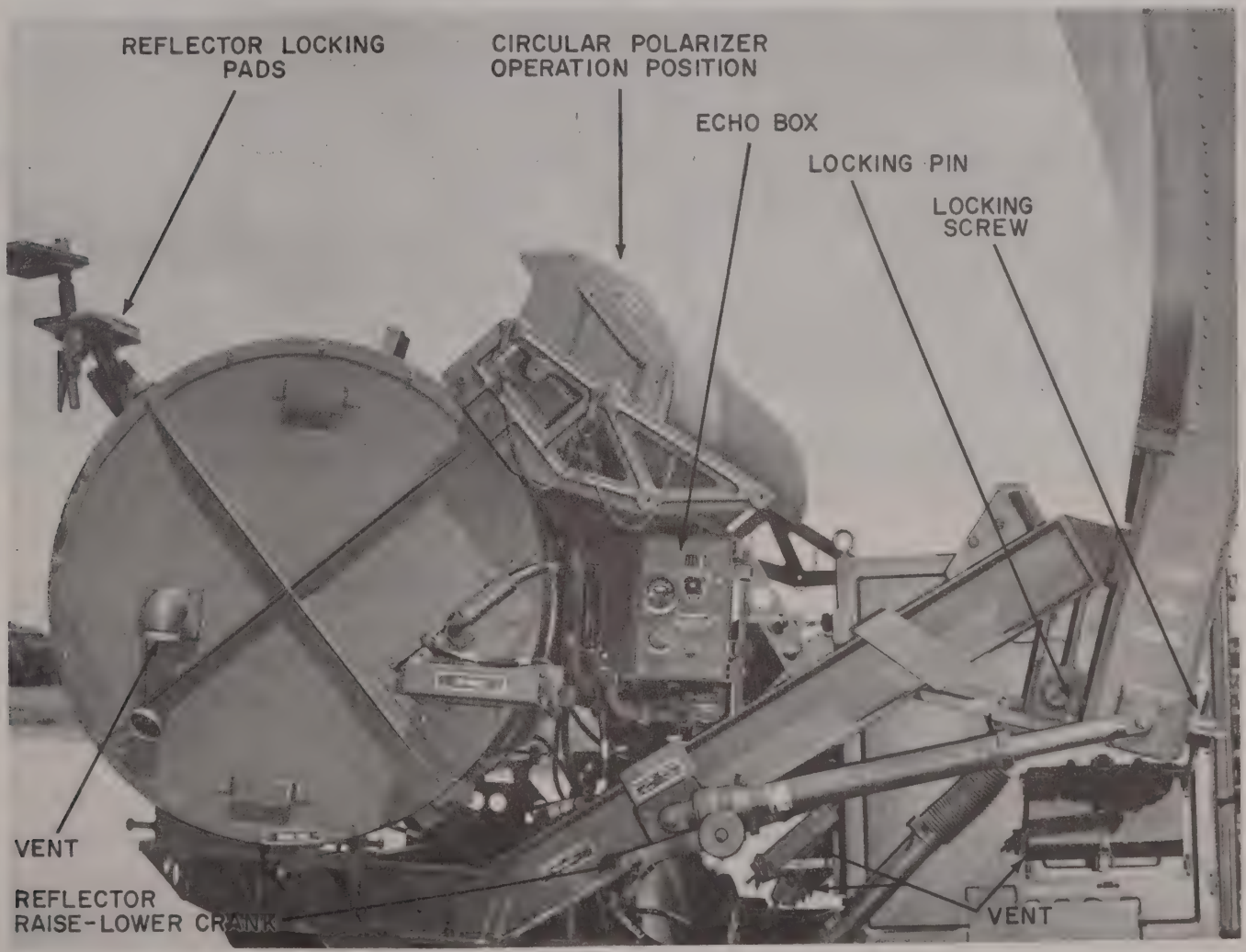

Figure 9. Partial side view of radar trailer.

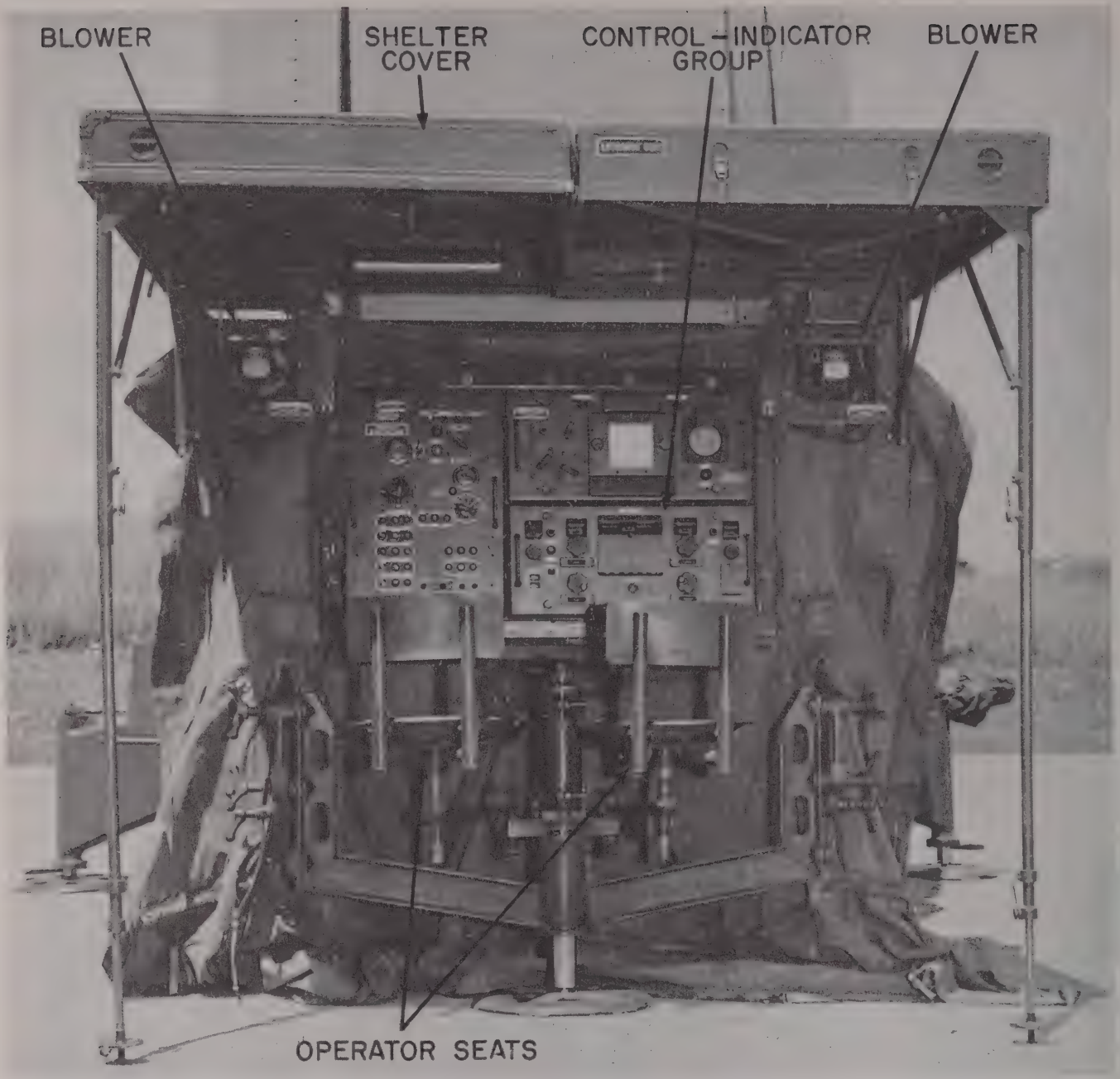

Figure 10. Control-indicator group with shelter cover mounted.

b. Power Unit.

(1) Disconnect the gas connecting hose from the gas can.

(2) Disconnect the exhaust extension and stow it in the generator trailer.

(3) Lower the canvas and tie it down.

(4) Couple the power unit trailer to its prime mover and raise the landing wheel.

(5) Raise the rear jack stand of the power unit trailer.

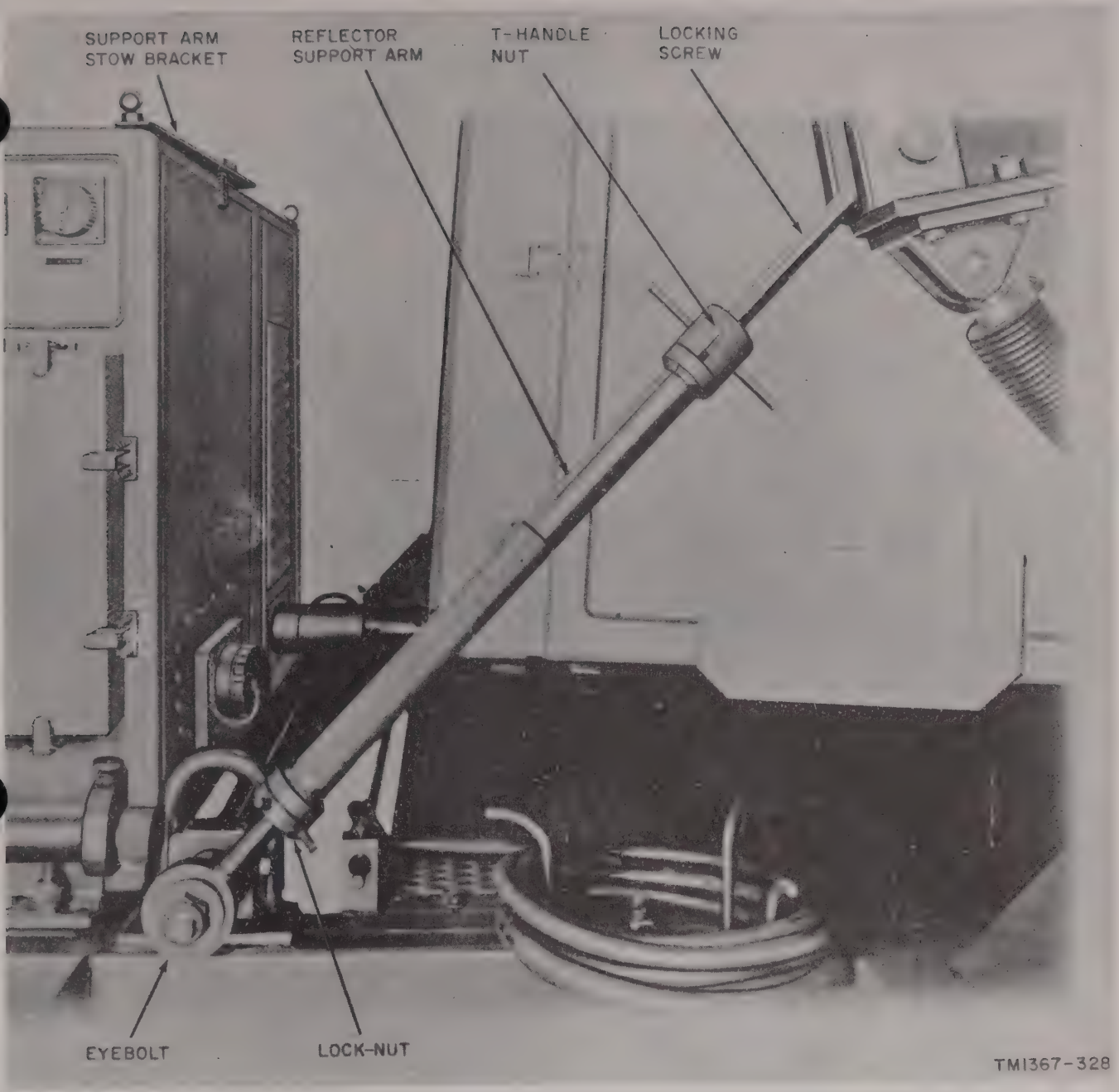

Figure 11. Reflector support arm in transit position.

Section II. PREOPERATIONAL CHECKS AND ADJUSTMENTS

10. Power Unit

Refer to TM 5–6115–365–15 or TM 5–5264 for preoperational checks and adjustments for the power unit.

11. Radar Set

a. Receiver-Transmitter Group.

(1) Set the AFC-MANUAL switch on the control-monitor panel (fig. 12) to the AFC position.

(2) Secure the control-monitor panel, the power supply drawer, and the transmitter door. Open the air intake and air exhaust panels on the rear of the cabinet and the air exhaust panel on the left side. Remove the cap from the vent at the upper left rear of the cabinet.

b. Control-Indicator Group.

(1) Secure the control-power supply, the azimuth and range indicator, and the computer drawers Open the air intake and air exhaust panels on

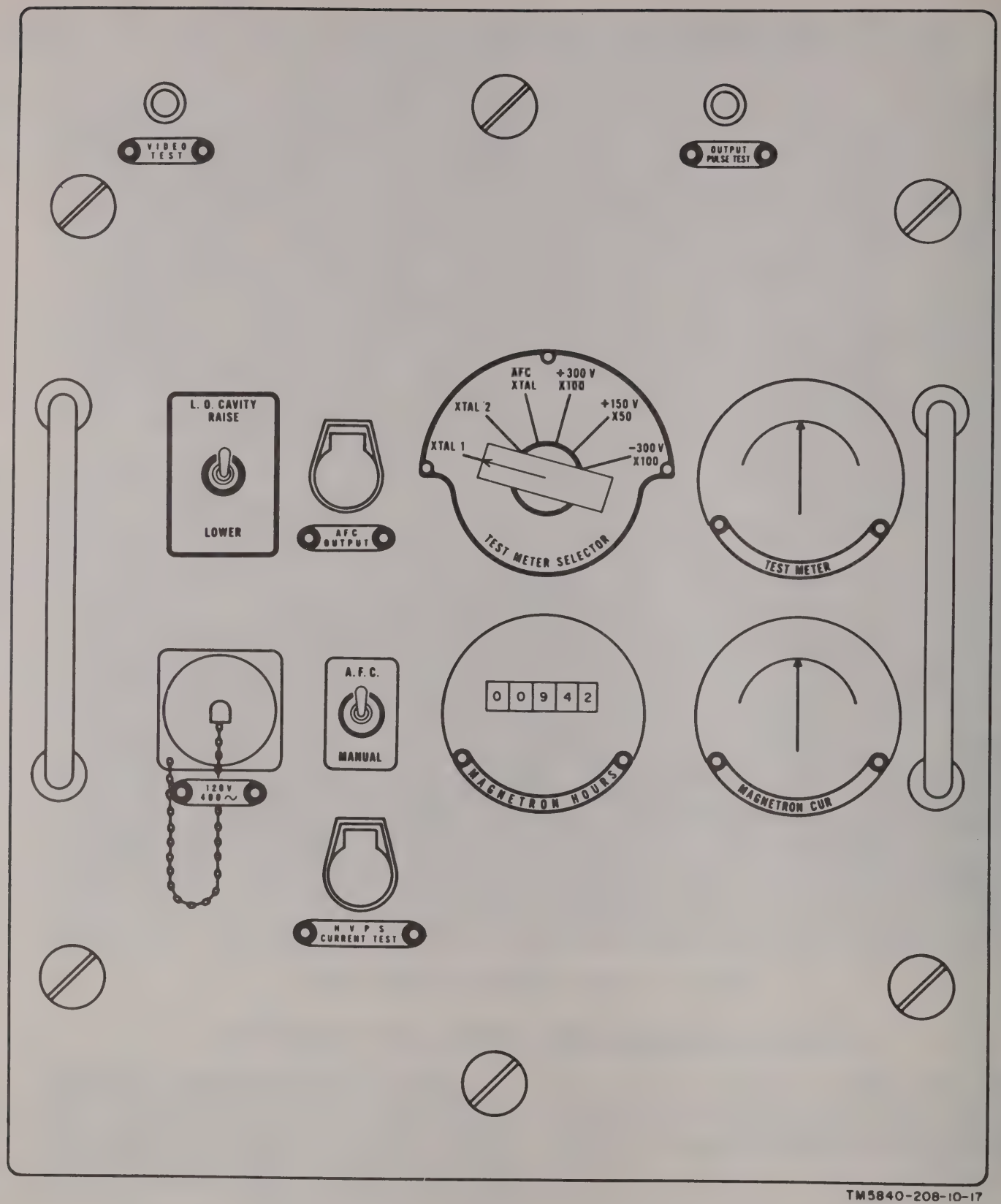

Figure 12. Control-monitor panel.

the left and right sides of the Cabinet. Remove the cap from the vent at the upper right rear of the cabinet.

(2) On the control-power supply panel (fig. 13 and 14), set the following switches in the positions indicated:

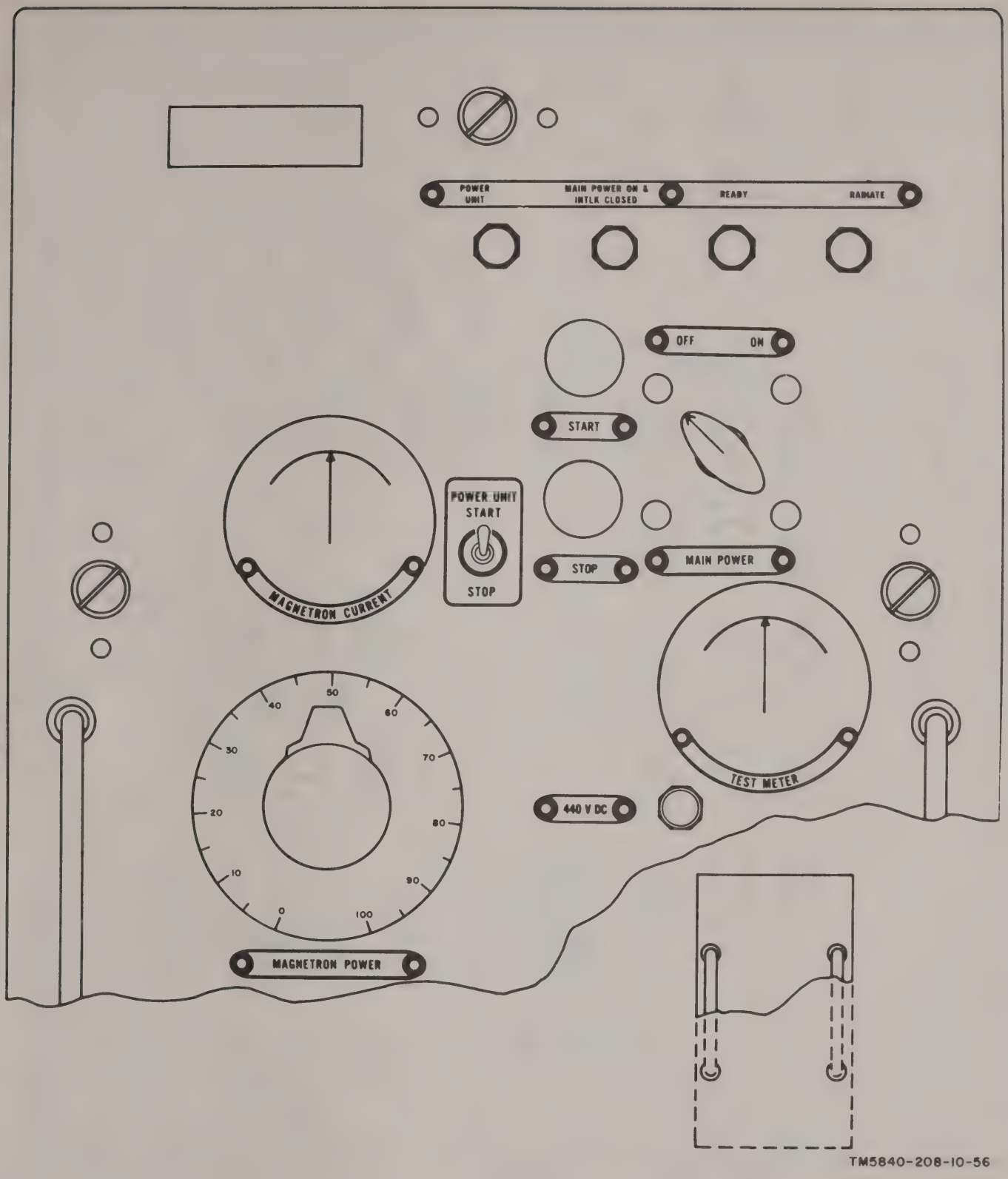

Figure 13. Control-power supply panel, upper half.

Control	*Position*
MAIN POWER switch	OFF
AFC-MANUAL switch	MANUAL
TEST METER SELECTOR switch	27 V X10

c. Antenna Group. Check to insure that the—

(1) Azimuth stowlock is out.

(2) Azimuth handwheel is all the way out.

(3) Fenders are down.

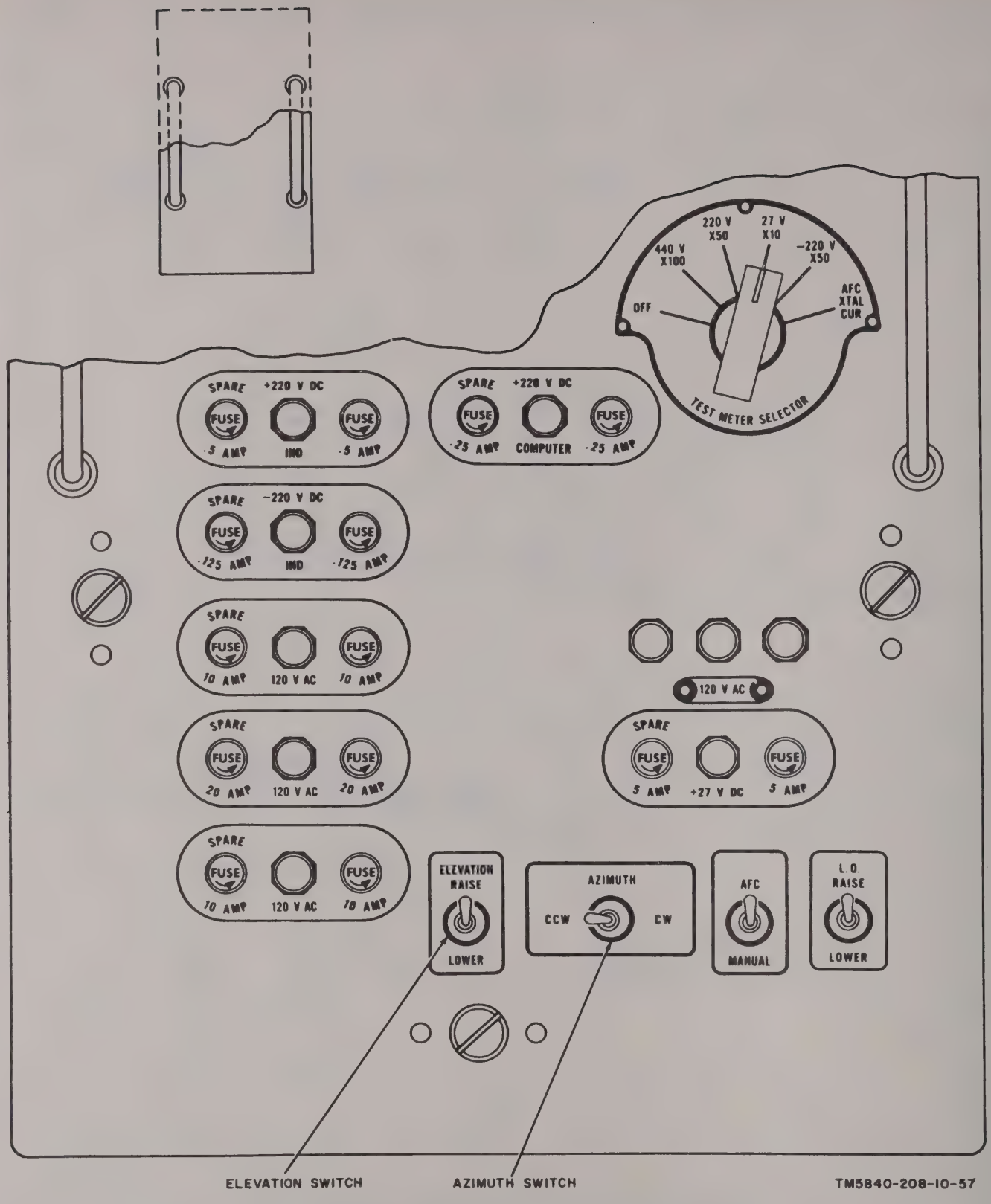

Figure 14. Control-power supply panel, lower half.

Section III. STARTING PROCEDURES

12. Power Unit

Refer to TM 5–6115–365–15 or TM 5–5264 for the starting procedure for the power unit.

13. Radar Set

a. Check the power unit outputs. When the proper voltage and frequency requirements have

been met, turn the power unit 400-hertz circuit breaker to ON. The POWER UNIT indicator lamp on the control-power supply panel will light if the output phases of the generator have been connected in the proper sequence.

b. On the control-power supply panel, turn the MAIN POWER switch to ON. The MAIN POWER ON & INTLK CLOSED indicator lamp should light, and the TEST METER should indicate 27 volts. If the meter does not indicate 27 volts ±3 volts, immediately turn the MAIN POWER switch to OFF. Check the power input voltages and connections. If the 27-volt fuse blows, immediately turn the MAIN POWER switch to OFF. Check the cable connections between the control unit and the pedestal for proper mating.

c. Check the operation of the system blowers. There are three blowers to be checked.

(1) Check the blowers in the receiver-transmitter cabinet by holding a piece of paper to the rear of the receiver-transmitter. If the inrushing air draws the paper against the receiver-transmitter compartment, the blower is operating. This check must be performed at both intake vents on the rear of the compartment to insure the operation of both the main blower and the magnetron blower.

(2) Check the blower on the control-indicator group. If air is being discharged at the exhaust vent on the right side of the cabinet, the blower is operating.

d. While waiting for the 5-minute delay relay to close, perform the following checks and adjustments:

(1) Thirty seconds after closing all drawers, rotate the TEST METER SELECTOR switches on the control-power supply panel and on the control-monitor panel through the positions listed below. The meter readings should be as indicated below.

TEST METER SELECTOR switch on the control-power supply (fig. 14):

Position	*Typical reading*
440 V X100	440 volts ±5
220 V X50	220 volts ±5
27 V X10	27 volts ±2
−220 V X50	−220 volts ±5
AFC XTAL CUR	2.5ma ±0.5

Note. Return the TEST METER SELECTOR switch to the AFC XTAL CUR position. TEST METER SELECTOR switch on the control-monitor panel (fig. 12):

Position	*Typical reading*
XTAL 1	2.5 ma ± 0.5
XTAL 2	2.5 ma ± 0.5
AFC XTAL	2.5 ma ± 0.5
+300 V X100	300 volts ± 5
+150 V X50	150 volts ± 5
−300 V X100	−300 volts ± 5

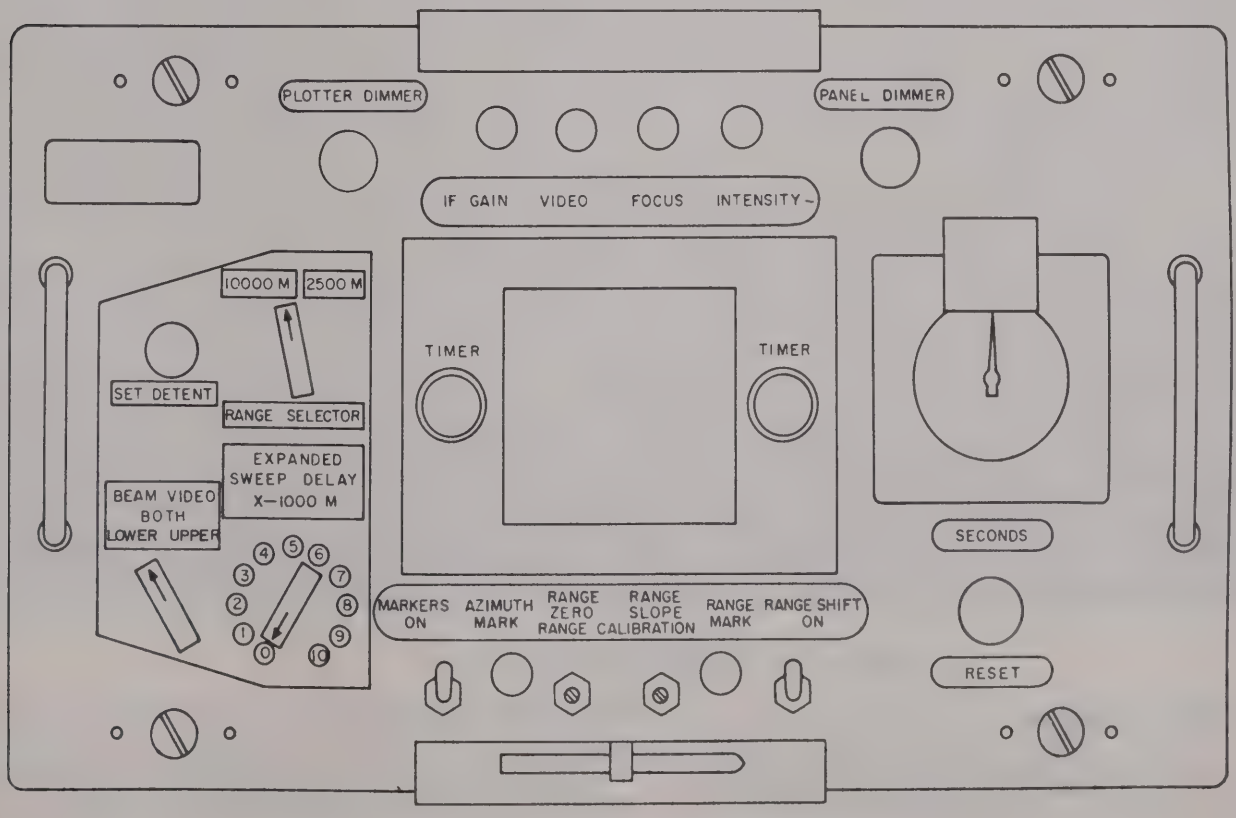

Figure 15. Azimuth and range indicator panel.

(2) Turn the AZIMUTH switch on the control-power supply panel to the CW position and then to the CCW position. The antenna and the azimuth counter on the computer should rotate accordingly.

(3) Operate the ELEVATION switch. With the switch in the RAISE position, the reflector should tilt upward and the elevation counter should increase. With the switch in the LOWER position, the reflector should tilt downward and the elevation counter should decrease.

e. After the 5-minute delay, the READY indicator lamp on the control-power supply panel should light. Check to see that the dehydrator pressure gage reads approximately 12 pounds per square inch (psi) and that the dry air indicator is blue.

f. Adjust the MAGNETRON POWER variac to a position between 0 and 25. Press the START button. The RADIATE indicator lamp should light. Adjust the variac until the MAGNETRON CURRENT meter reads 22 milliamperes (ma).

g. Rotate the VIDEO control (fig. 15) to its maximum position and the IF GAIN control to its minimum position.

h. With the RANGE SELECTOR switch in the 10000 M position, adjust the INTENSITY control until raster is just visible. The raster is a predetermined pattern of scanning lines which provides substantially uniform illumination of the cathode-ray tube.

i. Move the RANGE SELECTOR switch to the 2500 M position. If the intensity of the raster changes noticeably, have the radar repairman adjust the intensity balance.

j. Adjust the FOCUS control for the sharpest lines and images.

k. Adjust the IF GAIN control until the background noise is barely visible.

l. Adjust the RANGE MARK control until the range strobe is visible.

m. Adjust the AZIMUTH MARK control until the azimuth strobe is visible.

n. Place the AFC-MANUAL switch in the AFC position.

o. Turn the MARKERS switch to the ON position. The range markers should appear on the B-scope at ranges of 2,000, 4,000, 6,000, 8,000 and 10,000 meters. If the markers do not appear, the most probable cause is improper tuning of the local oscillator.

p. To tune the local oscillator—

(1) Place the AFC-MANUAL switch in the MANUAL position.

(2) Operate the LO switch on the control-power supply panel to the RAISE position until the markers appear. If no markers appear within 40 seconds, move the LO switch to the LOWER position. If markers do not appear within 2 minutes, notify the radar repairman.

(3) When the range markers appear, operate the LO switch to the RAISE position and then to the LOWER position until maximum marker intensity is obtained. Return the AFC-MANUAL switch to the AFC position. The marker intensity should remain unchanged. If a decrease in marker intensity occurs, the AFC circuit requires adjustment by the radar repairman.

(4) There are two local oscillator frequencies that will cause the range markers to appear at full brilliance—one 30 megahertz above and one 30 megahertz below the transmitter frequency. The lower frequency is correct and is the only frequency at which the AFC circuit will "lock in." The AFC circuit is operating properly if the range marker intensity remains unchanged and the AFC crystal current is steady when the AFC-MANUAL switch is placed in the AFC position. The AFC crystal current may be measured on the TEST METER by setting the TEST METER SELECTOR switch in the AFC XTAL CUR position. The normal meter reading is 2.5. During normal operation, place the TEST METER SELECTOR switch in the AFC XTAL CUR position.

(5) If the range markers fade out entirely when the AFC-MANUAL switch is placed in the AFC position, the local oscillator is probably tuned to the wrong frequency. To correct this, place the AFC-MANUAL switch in the MANUAL position and operate the LO switch to the LOWER position until the range markers reappear. Adjust the local oscillator for maximum intensity of the range markers. Return the AFC-MANUAL switch to the AFC position. No change in marker intensity should occur.

Section IV. OPERATIONAL CHECKS

14. Ringtime Check

The purpose of the ringtime check is to determine the overall efficiency of the transmitter and receiver. The ringtime check is performed as follows:

a. Turn on the radar set and adjust the antenna elevation to minimize clutter on the B-scope.

Figure 16. Echo box.

b. On the control-power supply panel, check the MAGNETRON CURRENT meter reading to insure a reading of 22 millamperes.

c. On the indicator panel, set the RANGE SELECTOR switch to the 10000 M position.

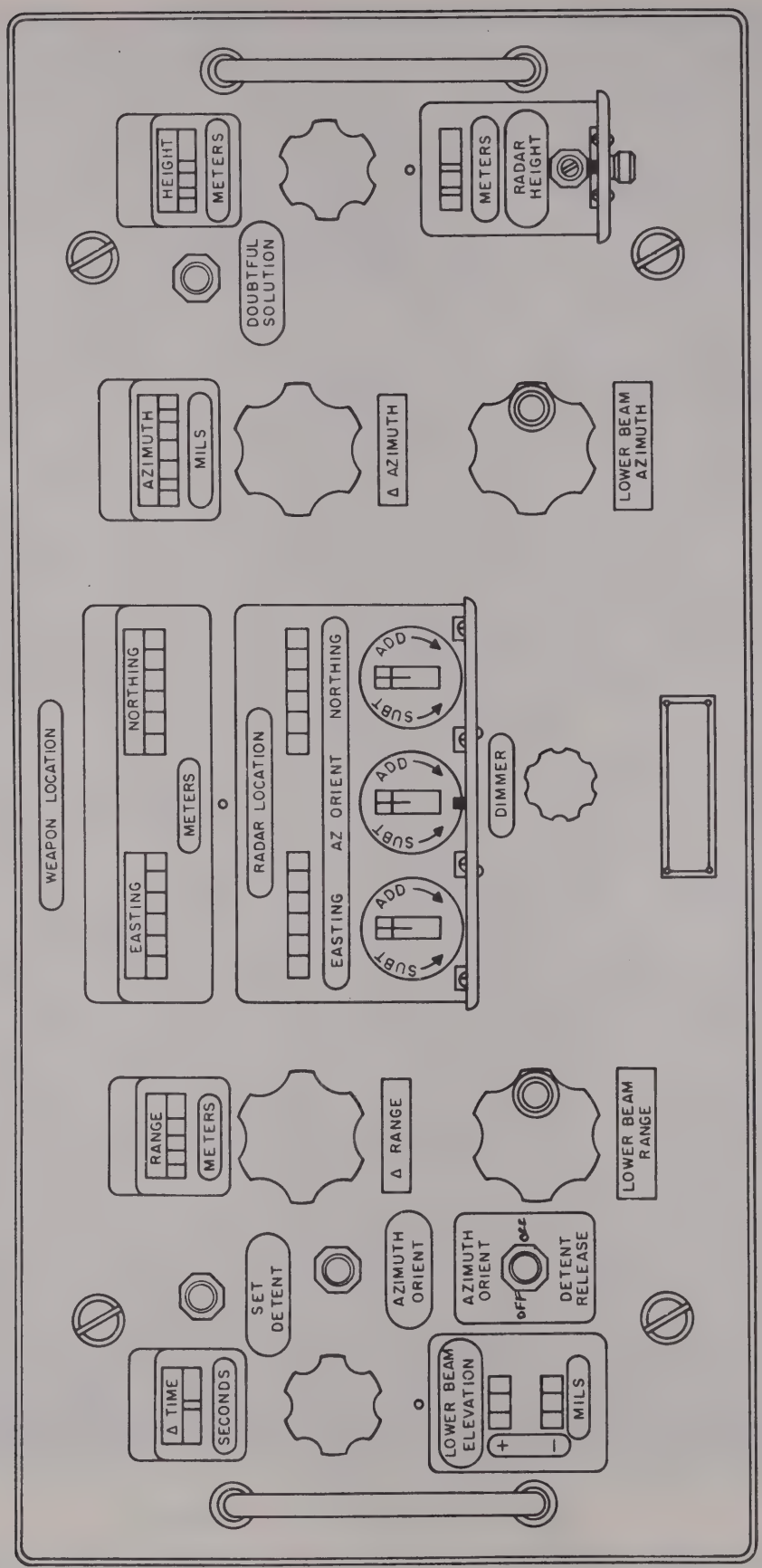

Figure 17. Radar data computer panel.

d. Turn the MARKERS switch to the ON position.

e. On the echo box (fig. 16), rotate the TUNE knob until a peak reading is obtained on the RELATIVE POWER meter.

f. On the indicator panel, rotate the EXPANDED SWEEP DELAY switch until the bright band covers the area where the noise on the B-scope starts to build up.

g. Set the RANGE SELECTOR switch to the 2500 M position.

h. Adjust the IF GAIN control for maximum ringtime display.

i. With the LOWER BEAM RANGE control on the radar data computer panel (fig. 17), place the range strobe over the point where the noise starts to build up.

j. Read the RANGE counter to obtain the ringtime distance. The minimum acceptable ringtime is 1,200 meters.

k. Detune the echo box.

l. Return the RANGE SELECTOR switch on the indicator panel to the 10000 M position.

NOTE: The automatic frequency control can be checked by the ringtime display. The ringtime measured with the AFC-MANUAL switch in the AFC position should not differ from the ringtime measured with it in the MANUAL position by more than 50 meters.

15. Azimuth Collimation Check

The purpose of the azimuth collimation check is to determine the angular separation between the optical axis and the center of scan. The procedure for performing this check is given in *a* through *e* below.

a. Determine the field correction in the following manner:

(1) Turn on the transmitter and allow the set to operate at least 30 minutes.

(2) On the echo box (fig. 16), rotate the TUNE knob until a peak reading is obtained on the RELATIVE POWER meter.

(3) Read the frequency of the transmitter on the FREQUENCY-MC scale above the echo box TUNE knob.

(4) Apply the frequency obtained in (3) above to the chart on the inside of the echo box cover (fig 18), interpolating if necessary. The value obtained is called the field correction. Figure 19 is a schematic drawing showing the results of a collimation check.

FREQUENCY	FIELD
16192	+12
16176	+11
16160	+10
16144	+ 9
16128	+8
16112	+7
16096	+6
16080	+5
16064	+4
16048	+3
16032	+2
16016	+1
16000	0
15984	-1
15968	-2
15952	-3
15936	-4
15920	-5
15904	-6
15888	-7
15872	-8
15856	-9
15840	-10
15824	-11
15808	-12

Figure 18. Frequency correction chart.

b. Select any target which can be positively identified both on the B-scope and through the orienting telescope. This target can be improvised, if necessary, and should be at least 500 meters from the radar. Place the RANGE SELECTOR switch in the 2500 M position, and position the EXPANDED SWEEP DELAY switch to a range which will display the desired target.

c. Move the radar in azimuth and elevation until the target is centered in the orienting telescope.

Caution: The azimuth handwheel on the frame of the radar should be used to move the antenna in azimuth. If the AZIMUTH switch on the control-power supply panel is used to move the antenna by small amounts, the azimuth brakes may be damaged.

d. On the computer panel, set the DETENT switch in the AZIMUTH ORIENT position, and place the Δ AZIMUTH control and the LOWER BEAM AZIMUTH control in detent.

e. The azimuth strobe should be off the center of the echo on the B-scope by the amount of the field

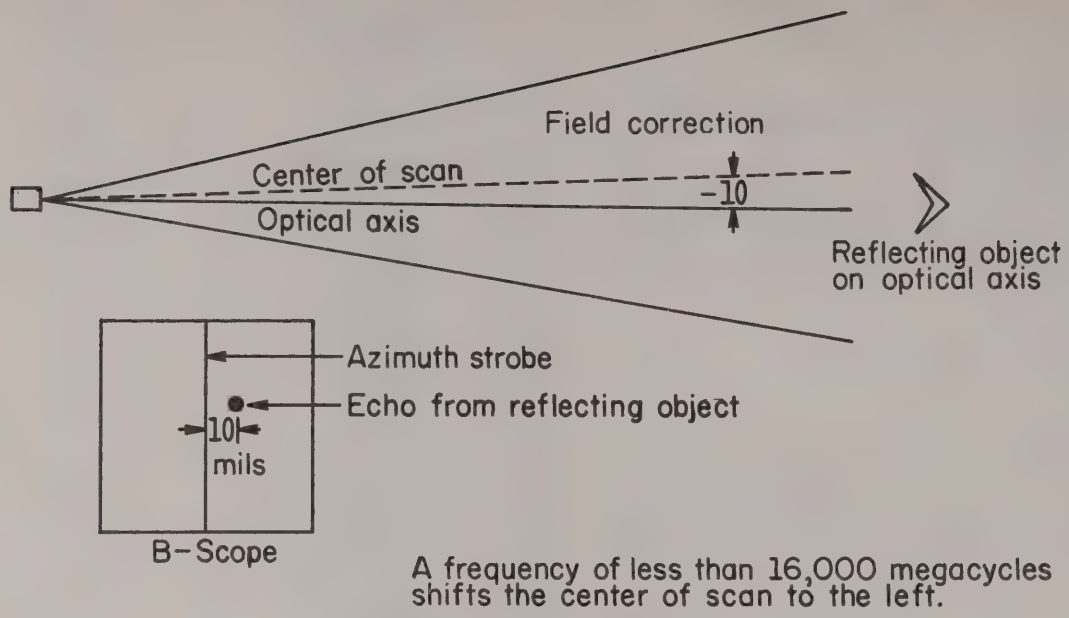

Figure 19. Collimation check.

correction. The strobe should be to the left if the correction is negative or to the right if the correction is positive. To verify the distance between the strobe and the center of the echo, note the azimuth reading; then place the DETENT switch in the OFF position, use the LOWER BEAM AZIMUTH control to move the azimuth strobe over the center of the echo, and read the azimuth counter. The difference between the two readings should be the value of the field correction.

16. Antenna Azimuth Orientation

The purpose of azimuth orientation is to set the correct azimuth reading on the computer panel AZIMUTH counter. There are two methods of orienting the antenna for azimuth—the electrical method and the optical method.

a. Azimuth Orientation (Electrical Method).

(1) On the indicator panel, turn the RANGE SELECTOR switch to the 2500 M position and the EXPANDED SWEEP DELAY switch to the range which will display the orienting point. Rotate the antenna until it is pointed generally toward the orienting point. Move the antenna in elevation, if necessary, until the orienting point appears as a target on the B-scope.

(2) On the computer panel, set the DETENT switch to the OFF position and Place the Δ AZIMUTH control in detent.

(3) Rotate the LOWER BEAM AZIMUTH control until the azimuth strobe bisects the target (orienting point) on the B-scope.

Note. It may be necessary to adjust the IF GAIN control on the indicator panel to reduce the size of the echo so that it may be more easily bisected.

(4) On the computer panel, hold the AZ ORIENT switch in the ADD (or SUBT) position until the AZIMUTH counter indicates the azimuth to the orienting point.

b. Azimuth Orientation (Optical Method). When the optical method of orientation is used, the orienting telescope is used to sight on the orienting point.

(1) Position the antenna so that the orienting point is centered in the telescope. Set the azimuth to the orienting point on the azimuth counter on the radar trailer frame.

(2) On the computer panel, set the DETENT switch to the AZIMUTH ORIENT position and place the Δ AZIMUTH control and the LOWER BEAM AZIMUTH control in detent.

(3) Apply the field correction, as indicated by its sign, to the azimuth to the orienting point. The result will be the corrected orienting azimuth.

Example:

When the field correction is positive:

Azimuth to the orienting point	1,653 mils
Field correction	+4 mils
Corrected orienting azimuth	1,657 mils.

When the field correction is negative:

Azimuth to the orienting point	1,653 mils
Field correction	−4 mils
Corrected orienting azimuth	1,649 mils.

(4) On the computer panel, hold the AZ ORIENT switch in the ADD (or SUBT) position until the AZIMUTH counter indicates the corrected azimuth.

(5) Move the antenna in azimuth and elevation until a target echo, which can be easily identified, is found. Read and record the azimuth and range to this target. This target can be used for future orientation checks and as a electrical orienting pointing during periods of poor visibility.

(6) If correct results are not obtained during azimuth collimation, notify the radar repairman. If no radar repairman is available, the equipment may still be operated by applying the difference in azimuth between the orienting telescope and the B-scope. The difference should be applied in the same manner as the field correction obtained from the echo box.

17. Elevation Orientation Check

The purpose of an elevation orientation check is to verify the alinement of the orienting telescope with the elevation dials. This check is used in applications such as a high-burst registration. The checkpoint may be a fixed point of known elevation, or it may be a fire control instrument, such as an aiming circle. To perform the elevation orientation check—

a. Check the level of the set.

b. Position the antenna so that the checkpoint is centered in the orienting telescope.

c. Determine the correct elevation to the checkpoint from the antenna ELEVATION-DEPRESSION counter on the frame of the radar. Record for future reference any error greater than 1 mil. Any vertical angle correction (VAC) recorded must be applied to the mean elevation deviation spottings for high-burst registrations.

18. Range Calibration

The purpose of range calibration is to aline the range circuits so that the actual range will be indicated on the range counter. Before range calibration is performed, power must be applied to the radar, the transmitter must be on, and the local oscillator must be tuned.

a. The procedure for performing range calibration with the range markers is as follows:

(1) On the indicator panel (fig. 15), t rn the RANGE SHIFT switch to the OFF position.

(2) On the computer panel (fig. 17), set the DETENT switch to the OFF position and set the Δ RANGE control in detent. This will allow any given range to be set into the computer.

(3) Set the range strobe to 2,000 meters by using the LOWER BEAM RANGE control.

(4) On the indicator panel (fig. 15), set the RANGE SELECTOR switch to the 2500 M position.

(5) Set the EXPANDED SWEEP DELAY switch to position I.

(6) Set the Markers switch to the ON position. An adjustment of the IF GAIN control may be necessary to cause the markers to appear at proper intensity.

(7) If the range marker does not fall exactly over the strobe, adjust the RANGE ZERO control until it does.

(8) Set the EXPANDED SWEEP DELAY switch to position 7.

(9) Set the range strobe to 8,000 meters.

(10) If the range marker does not appear exactly over the strobe, adjust the RANGE SLOPE control until it does.

(11) Since the RANGE ZERO and RANGE SLOPE controls interact, recheck the RANGE SLOPE adjustment at 8,000 meters after each change in RANGE ZERO at 2,000 meters and recheck the RANGE ZERO adjustment at 2,000 meters after each change in RANGE SLOPE at 8,000 meters.

b. To verify the range calibration, measure the range to an electrical target with the radar set. This reading should be within 20 meters of the surveyed range.

19. Computer Alinement Checks

The purpose of the computer alinement check is to insure that the computer is providing accurate locations.

a. Compare the reading on the ELEVATION-DEPRESSION counter on the antenna with the reading on the LOWER BEAM ELEVATION counter on the computer as follows:

(1) Use the ELEVATION switch on the control-power supply panel to position the antenna in elevation so that the following readings are obtained on the LOWER BEAM ELEVATION counter on the computer panel: —100, —50, 0, 50, 100, 150, and 20 mils.

(2) Check to insure that the readings on the antenna ELEVATION-DEPRESSION counter correspond to those in (1) above. If the readings are not within 2 mils, notify the radar repairman.

b. Check the azimuth controls on the computer panel and the B-scope on the indicator panel as follows:

(1) Set the DETENT switch to the OFF position, and place the Δ AZIMUTH control in detent.

(2) Rotate the LOWER BEAM AZIMUTH control clockwise. The AZIMUTH counter reading should *increase,* and the B-scope azimuth strobe should move to the right.

(3) Rotate the LOWER BEAM AZIMUTH control counterclockwise. The AZIMUTH counter reading should *decrease,* and the B-scope azimuth strobe should move to the left.

(4) With a white grease pencil, make a short, thin, vertical line on the face of the B-scope.

(*a*) Using the LOWER BEAM AZIMUTH control, superimpose the azimuth strobe over the vertical line. Make the last movement of the LOWER BEAM AZIMUTH control in a clockwise direction. Note the reading on the AZIMUTH counter.

(*b*) Repeat (*a*) above, making the last movement of the LOWER BEAM AZIMUTH control in a counterclockwise direction. Note the reading on the AZIMUTH counter.

(*c*) The two readings obtained in (*a*) and (*b*) above should agree. If the readings do not agree, notify the radar repairman.

(5) Set the DETENT switch to the DETENT RELEASE position and check to see that the SET DETENT indicator light on both the computer panel and the indicator panel are on.

(6) Rotate the Δ AZIMUTH control clockwise. The AZIMUTH counter reading should *decrease,* and the B-scope azimuth strobe should move to the right.

(7) Rotate the Δ AZIMUTH control counterclockwise. The AZIMUTH counter reading should *increase,* and the B-scope azimuth strobe should move to the left.

c. Check the range controls on the computer panel and the B-scope on the indicator panel as follows:

(1) Rotate the LOWER BEAM RANGE control clockwise. The RANGE counter reading should *increase,* and the B-scope range strobe should move *up.*

(2) Rotate the LOWER BEAM RANGE control counterclockwise. The RANGE counter reading should *decrease,* and the B-scope range strobe should move *down.*

(3) Rotate the Δ RANGE control clockwise. The RANGE counter reading should *decrease,* and the B-scope range strobe should move *up.*

(4) Rotate the Δ RANGE control counterclockwise. The RANGE counter reading should *increase,* and the B-scope range strobe should move *down.*

(5) Move the DETENT switch to the OFF position and place the Δ RANGE and Δ AZIMUTH controls in detent. The SET DETENT indicator lights should go out.

d. On the computer panel, check the RADAR HEIGHT counter by rotating its adjustment screw. The RADAR HEIGHT counter reading should change, and the weapon HEIGHT counter reading should also change the same amount.

e. On the computer panel, check the weapon HEIGHT counter by rotating its control knob. Only the reading on the weapon HEIGHT counter should change.

f. On the computer panel, check the RADAR LOCATION counters and the WEAPON LOCATION counters as follows:

(1) Hold the RADAR LOCATION EASTING switch in the SUBT position. Both EASTING counter readings should decrease.

(2) Hold the RADAR LOCATION EASTING switch in the ADD position. Both EASTING counter readings should increase.

(3) Repeat (1) and (2) above with the RADAR LOCATION NORTHING switch for both NORTHING counter readings.

g. Check the accuracy of the AZIMUTH counter movement as follows:

(1) Note the reading on the azimuth counter on the radar frame. Using the LOWER BEAM AZIMUTH control, set the same reading on the computer AZIMUTH counter.

(2) Open the computer drawer far enough to disengage the interlock.

(3) Rotate the antenna approximately 1,500 mils left or right.

(4) Close the computer drawer. When the AZIMUTH counter on the computer panel stops, compare its reading with the reading on the azimuth counter on the radar frame. The two readings should agree within 1 mil.

(5) Repeat (1) through (4) above for two additional antenna positions. If the readings obtained do not agree with 1 mil, notify the radar repairman.

Radar set serial number_____ Date of alinement_____ Alined by_____

Problem number	Lower beam azimuth	Elevation	Lower beam range	Upper beam azimuth	Upper beam range	Time	Weapon height	Output data	
								Easting	Northing
1	0000	+20	8,000	0030	8,200	2.0	300		
2	1600	+40	5,000	1620	5,100	2.0	400		
3	3200	+10	8,000	3170	7,800	1.5	50		
4	4800	+40	5,000	4780	4,900	4.0	200		

Figure 20. Computer accuracy check.

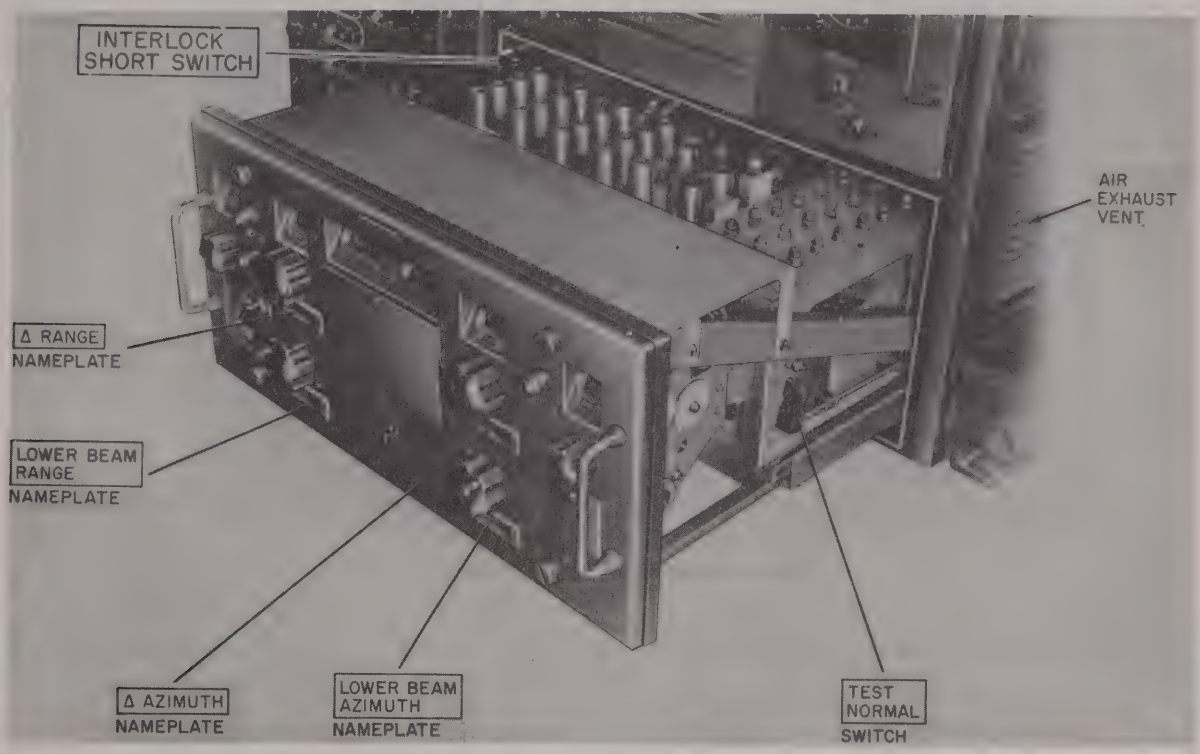

Figure 21. Partial view of radar data computer.

h. After all the components of the computer have been checked, check the accuracy of the computer. The accuracy check consists of a series of four problems (fig. 20), which are set into the computer. Each day and/or each time the set is moved, the operator should perform the accuracy check and ccmpare the output data against the solutions furnished by the radar repairman. The accuracy check is performed as follows:

(1) Insure that the computer drawer is open and that the INTERLOCK SHORT switch is closed (fig. 21).

(2) Check that the reading on the BEAM SEPARATION dial (fig. 22) on the left side of the computer drawer is the same as that on the beam separation plate on the antenna.

(3) Insert the radar location data into the computer.

(*a*) Use the EASTING and NORTHING switches to set the EASTING and NORTHING counters to zero.

Note. If the actual radar location data has already been inserted into the computer, it is not necessary to set the EASTING and NORTHING counters to zero. Algebraically add the actual radar EASTING and NORTHING to the WEAPON LOCATION EASTING and NORTHING (the answer to the problem) and compare the resulting values with the problem solution furnished by the radar repairman.

(*b*) Set the RADAR HEIGTH counter to 300 meters.

(4) Set the radar at the proper angle of elevation.

(5) Set the DETENT switch to its OFF position.

(6) Place the Δ RANGE AND Δ AZIMUTH controls in detent.

(7) Insert the azimuth, using the AZIMUTH switch on the control-power supply panel and the

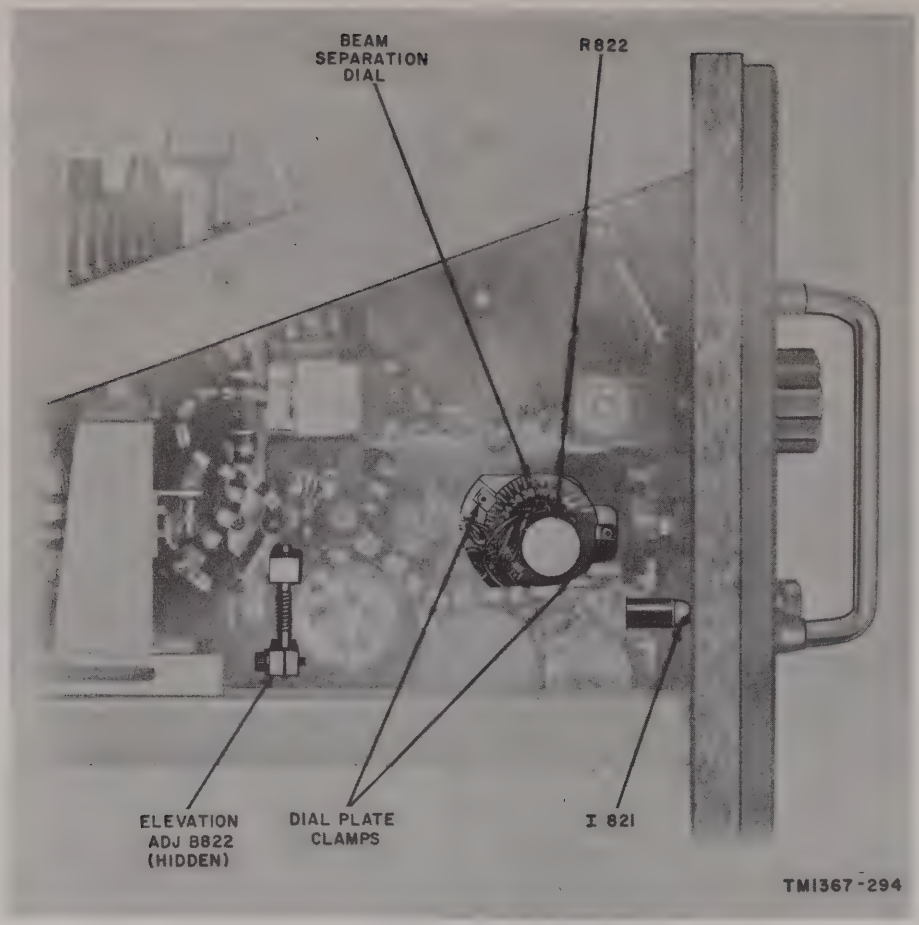

Figure 22. Beam separation dial on radar data computer.

LOWER BEAM AZIMUTH control on the computer panel.

(8) Insert the lower beam range.

(9) Turn the TEST-NORMAL switch (fig. 21) to the TEST position.

(10) Set the DETENT switch to DETENT RELEASE.

(11) Insert the upper beam azimuth with the Δ AZIMUTH control.

(12) Insert the upper beam range with the Δ RANGE control.

(13) Turn the TEST-NORMAL switch (fig. 21) to the NORMAL position.

(14) Insert the time with the TIME knob.

(15) Insert the weapon height into the computer.

(16) Check the WEAPON LOCATION EASTING and NORTHING against the problem solution furnished by the radar repairman.

(17) The error in either easting or northing should not exceed 20 meters, and the sum of the errors in easting and northing should not exceed 36 meters. If the answer to any problem is out of tolerance, notify the radar repairman.

(18) Repeat (4) through (16) above for the remaining problems.

20. Radar Location Data

After completing the computer accuracy check, establish the grid reference of the radar by inserting the true radar location into the computer as follows:

a. Use the RADAR LOCATION EASTING and NORTHING switches to insert the grid reference of the radar location into the computer.

b. Use the RADAR HEIGHT knob to insert the altitude of the radar in *meters* into the computer.

c. If maps are available, determine the average altitude of the terrain in the area of interest in meters and insert this altitude into the weapon HEIGHT counter on the computer. If maps are not available, insert the altitude of the radar into the weapon HEIGHT counter.

Section V. STOPPING PROCEDURES

21. Radar Set

The procedure for stopping the radar set is as follows:

a. Press the STOP switch on the control-power supply panel to turn off the transmitter.

b. Elevate the antenna to approximately + 175 mils.

c. Turn the MAGNETRON POWER variac fully counterclockwise to lower the magnetron current.

d. Turn the MAIN POWER switch to the OFF position. The READY indicator lamp and the MAIN POWER ON & INTLK CLOSED indicator lamp will go out.

22. Power Unit

The procedure for stopping the power unit is as follows:

a. Place the CIRCUIT BREAKER in the OFF position.

b. Place the GOVERNOR CONTROL in the START AND IDLE position. Allow the engine to run at idle speed for a few minutes.

c. Place the START-STOP switch in the STOP position.

d. Place the fuel selector valve in the OFF position.

e. Perform the after-operation maintenance check.

CHAPTER 4
WEAPON AND IMPACT LOCATION

Section I. PERSONNEL

23. General

A well-trained radar crew is essential to insure accurate, timely locations of hostile weapons. Continuous operation may be required during combat; therefore, every man in the section must be capable of performing each of the duties necessary to obtain and process hostile weapon locations.

24. Organization of Personnel for Operation

a. For continuous operation, the section should be organized into two 3-man teams, excluding the chief of section and the radar repairman, who are on call continuously.

b. The duties of the members of each three-man team are as follows:

(1) The *control unit operator* operates the radar and the computer, using the controls of the control-indicator group.

(2) The *plotter* sets up the radar chart on a grid sheet, determines the altitudes of the weapon locations from a contour map, plots the final locations, keeps the necessary records, and operates the communication equipment.

(3) The *generator operator* operates and maintains the generator, provides local security, and assists the plotter during periods of intense enemy weapons activity.

c. To prevent fatigue and eyestrain, the members of the team should alternate their duties so that no one member serves as the control unit operator more than 30 minutes at a time. When the teams are changed, the personnel on duty should be relieved one at a time. This will allow each person to become familiar with the situation as he assumes his duty, since he will be working with two men who are already familiar with the situation.

Section II. WEAPON LOCATION

25. General

The radar has a capability to detect and locate mortars and a limited capability to detect and locate cannon artillery and rocket-launching sites. The techniques employed in locating mortars may be divided into two phases—detection and location. Both phases can be accomplished with the same projectile.

26. Detection

a. A sector of search will be assigned to the radar. Normally, this sector of search will be the zone of action of the supported unit and, as such, will vary with the tactical situation. The radar should be sited for maximum coverage of its assigned sector of search. Depending on the sector width and the location of the radar, the entire sector may be covered with one position of the radar antenna (445-mil sector width). However, the sector of search may be so large that the radar will be capable of scanning only a portion at any one time. If so, the radar should scan one portion for a short period of time and then another portion until the entire sector has been covered.

b. When a projectile is fired so that it passes through both beams of energy sent out by the radar set AN/MPQ–4A (fig. 23), the point at which the projectile intersects each beam is indicated by a bright spot (echo) on the B-scope. The elapsed time between the appearance of these echoes is measured with the timer. The transparent cover over the B-scope is a reflection-type plotter. As each echo appears on the B-scope, a mark is made on the plotter with a white grease pencil to indicate the exact location of the point at which the projectile intersected the beam of

energy. The mark on the plotter is reflected on the cathode-ray tube behind the plotter. This feature eliminates errors due to parallax between the echo on the cathoderay tube and the white grease pencil mark on the plotter. Careful adjustment of the PLOTTER DIMMER control is necessary to make the reflections clearly visible. The grease pencil marks are placed so that their reflections are centered over the echoes. These two operations, i.e., measuring the elapsed time and marking the B-scope, constitute the detection phase of weapon location.

27. Operating Procedure

a. Move the AZIMUTH switch on the control-power supply panel to the CW (clockwise) or CCW (counterclockwise) position to rotate the antenna to any 445-mil sector of the anticipated target area.

b. Move the ELEVATION switch to its RAISE or LOWER position to position the reflector so that the elevation angle will be 10 mils above the highest point on the screening crest. At this point, ground clutter should decrease.

Note. Use the telescope to determine the elevation angle to the top of the screening crest.

c. Place the RANGE SHIFT switch on the indicator panel in the ON position. This will displace the video display of the upper and lower beams so that the two target echoes will not appear as one.

d. When the projectile passes through the two beams, two target echoes will appear, one from the lower beam and one from the upper beam (fig. 24). At the instant the first echo is seen on the B-scope, press either of the two TIMER buttons on the indicator panel to start the SECONDS timer and mark the presentation with a white grease pencil. When the second echo appears, press either TIMER button again to stop the SECONDS timer and mark the second presentation with the grease pencil. The elapsed time between echoes will appear on the SECONDS timer.

28. Computing the Weapon Location

a. Place the DETENT switch in the OFF position and the △ RANGE and △ AZIMUTH controls in detent. Turn the LOWER BEAM RANGE control until the lower range strobe intersects the first (lower beam) mark on the B-scope (fig. 25).

b. Turn the LOWER BEAM AZIMUTH control until the Azimuth strobe intersects the lower echo mark.

c. Place the DETENT switch in the DETENT RELEASE position.

d. Rotate the △ RANGE control until the upper beam range strobe intersects the upper beam mark on the B-scope (lg. 26).

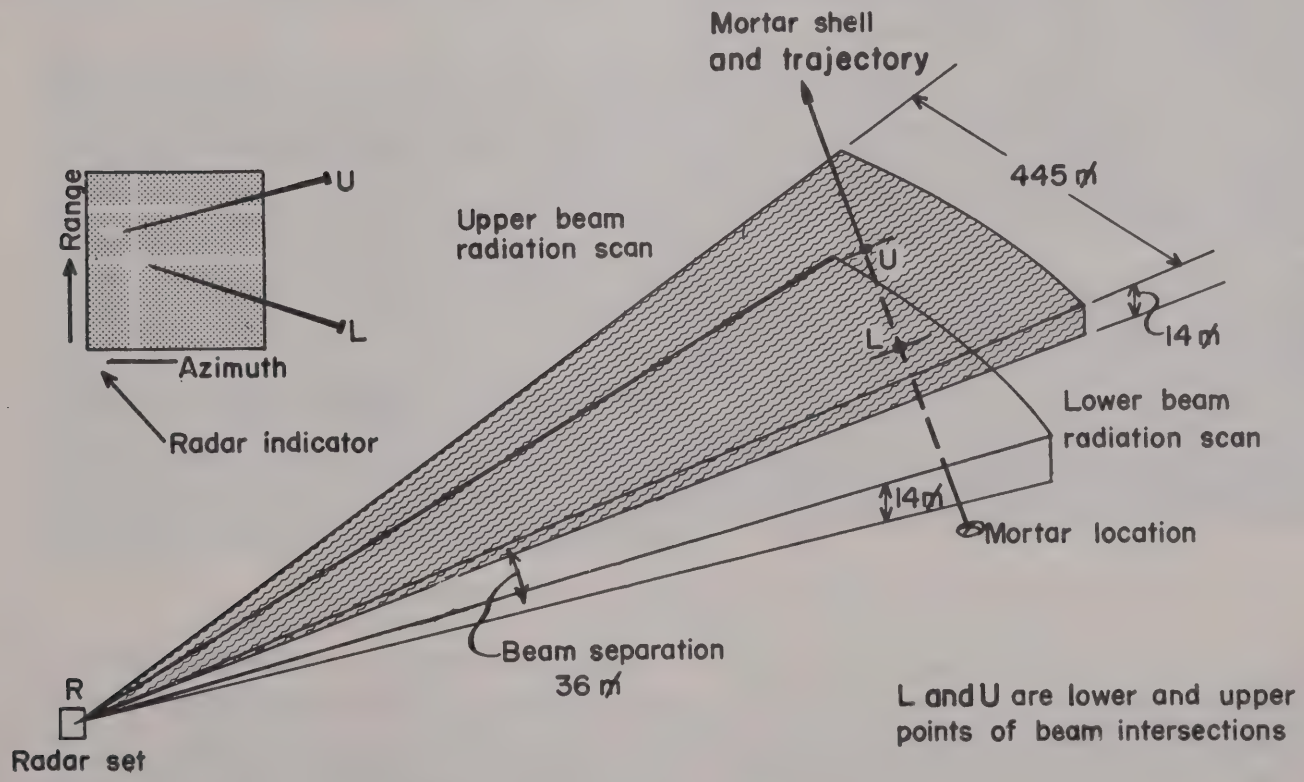

Figure 23. Scanning pattern for weapon location.

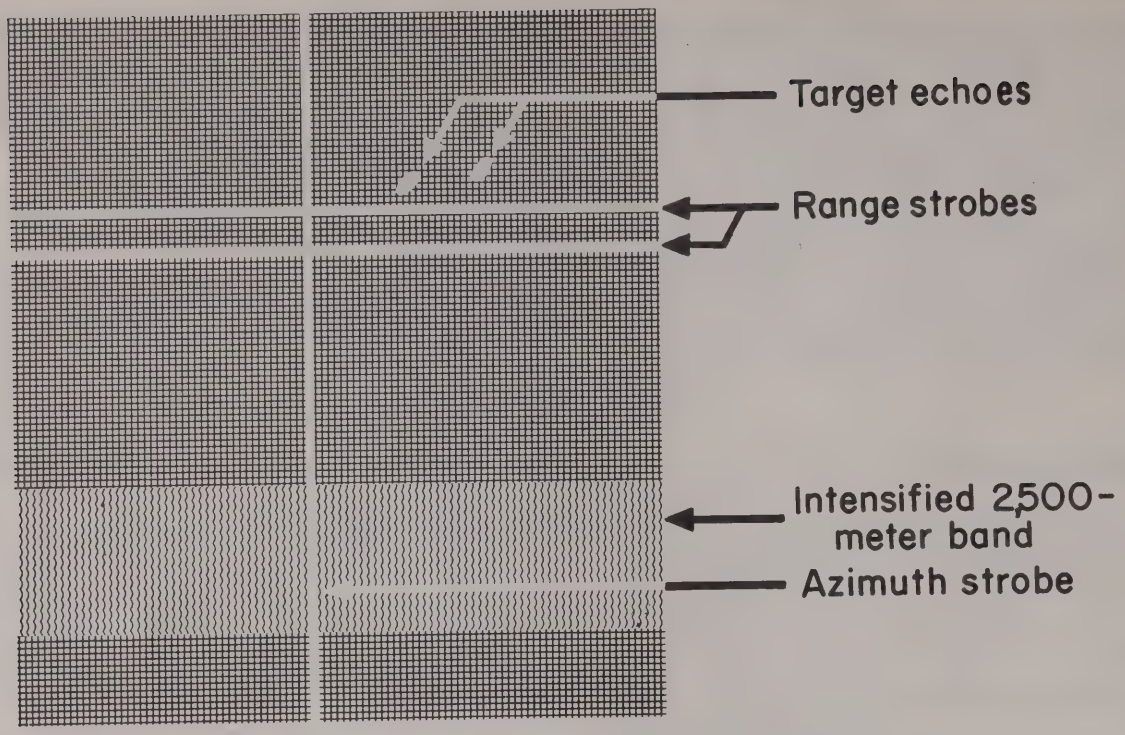

Figure 24. B-scope presentation (10,000-meter range sweep).

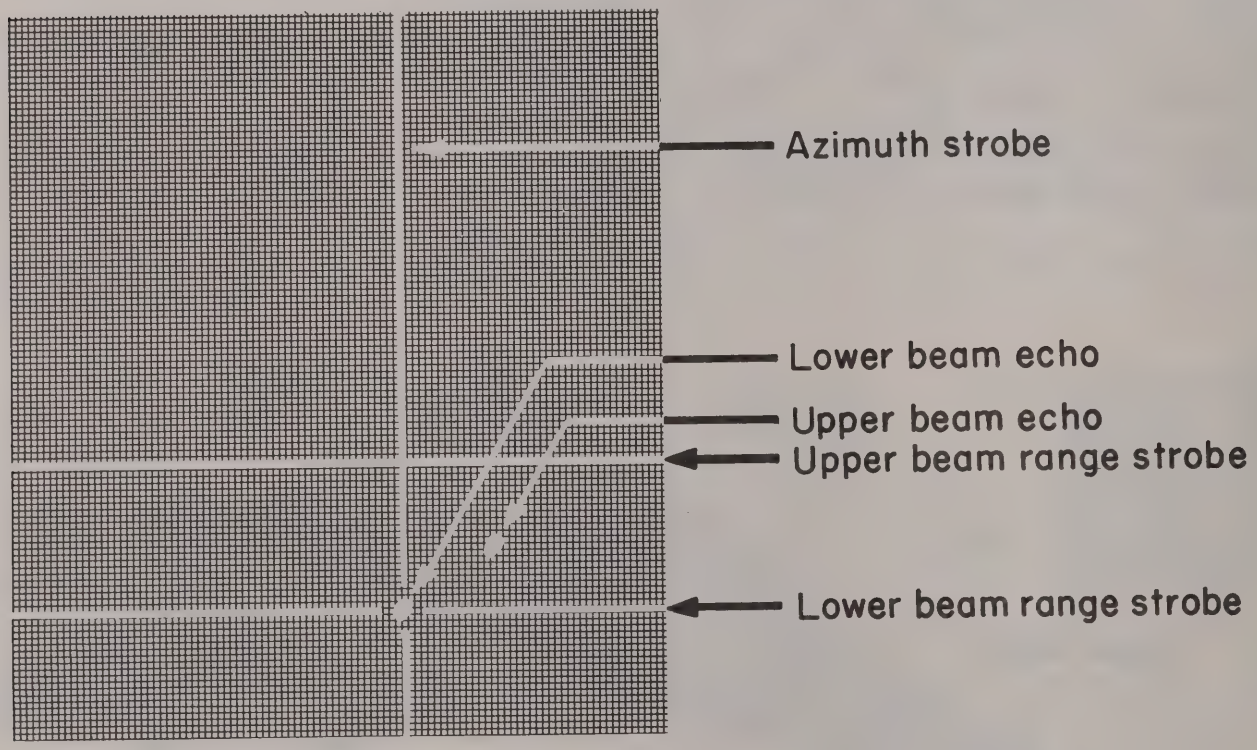

Figure 25. Strobing the lower echo (2,500-meter range presentation).

e. Rotate the Δ AZIMUTH control until the azimuth strobe intersects the upper beam mark.

f. Rotate the Δ TIME control until the time lapse between the appearance of the two echoes appears on the Δ TIME counter.

g. Read the WEAPON LOCATION EASTING and NORTHING counters to obtain the uncorrected grid coordinates of the weapon. The uncorrected polar coordinates of the weapon are read from the RANGE and AZIMUTH counters.

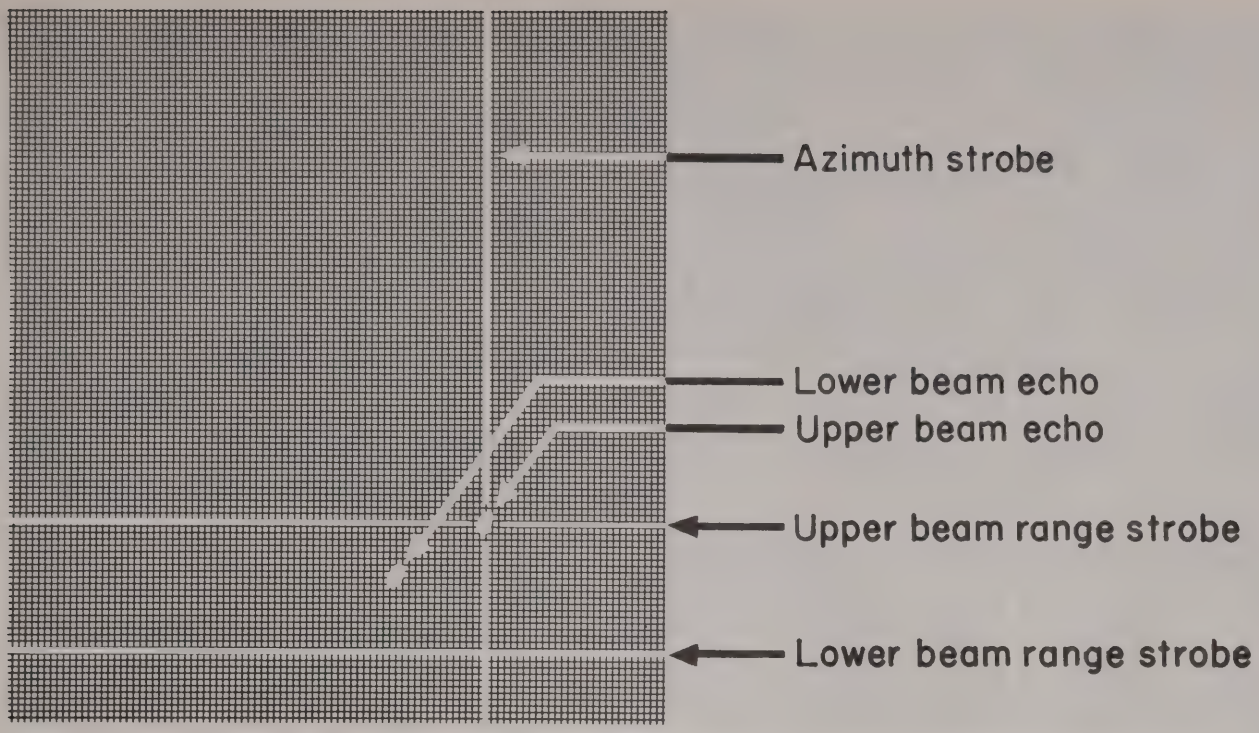

Figure 26. Strobing the upper echo (2,500-meter range presentation).

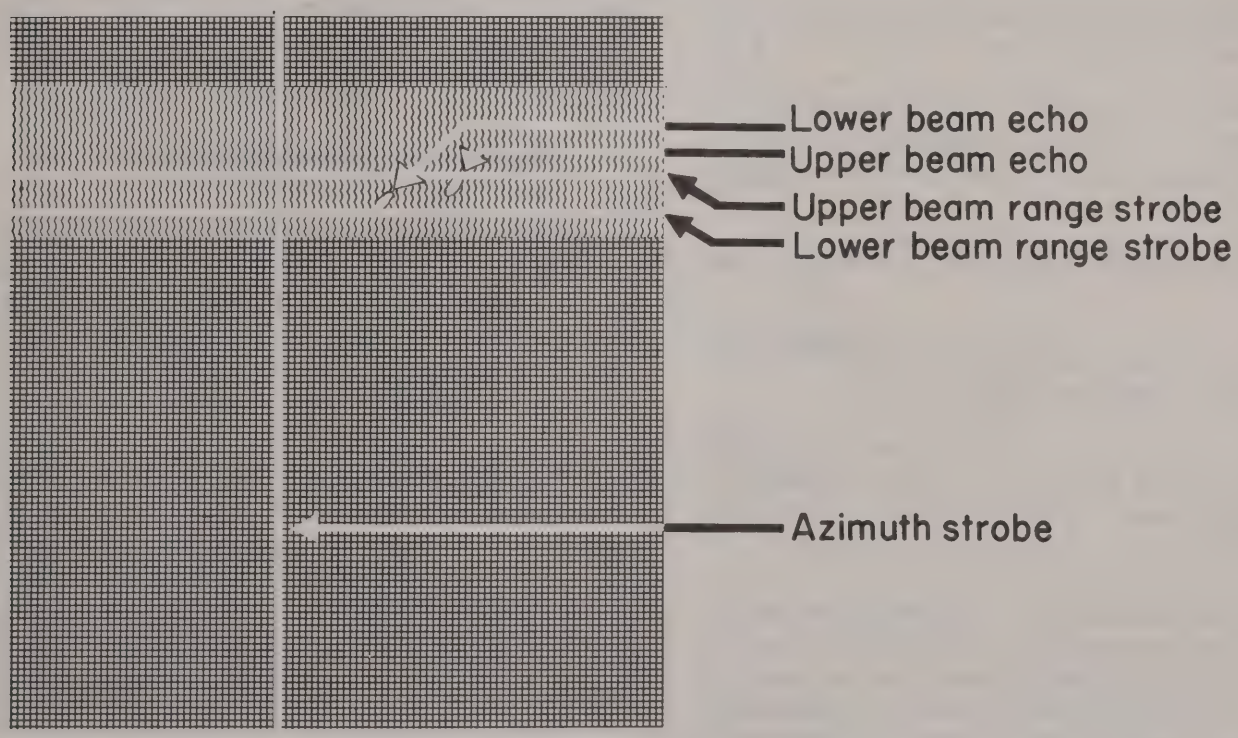

Figure 27. 2,500-meter bright band over the point where the echoes appeared.

29. Corrections for Difference in Altitude

a. If, after plotting a weapon location on a contour map, it is determined that the altitude of the plotted point differs from that of the radar by more than 20 meters, set the altitude of the plotted point in meters on the weapon HEIGHT counter. This action may change the weapon location coordinates.

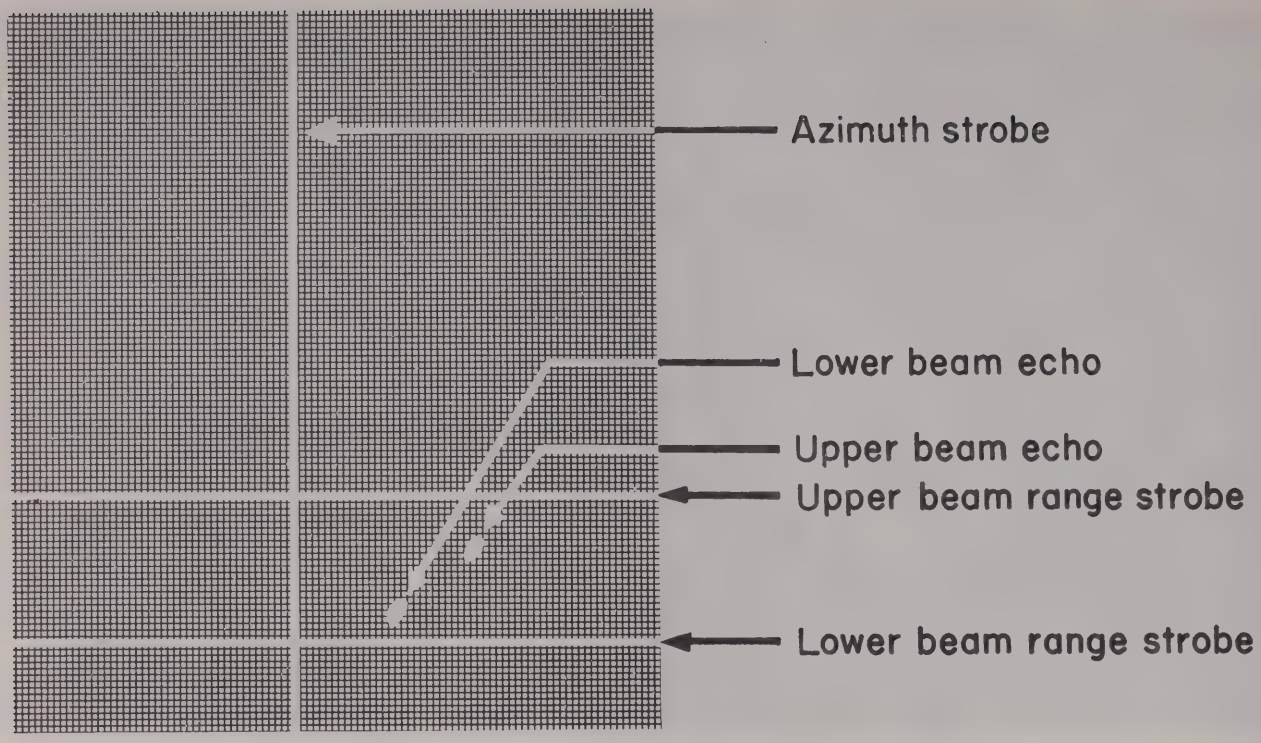

Figure 28. Echo presentation of a subsequent round with 2,500-meter range presentation.

b. Make certain that the DOUBTFUL SOLUTION indicator lamp is off.

c. Read and record the final values on the WEAPON LOCATION EASTING and NORTHING counters to obtain the location of the weapon position.

d. Place the DETENT switch in the OFF position.

e. Reset the Δ RANGE and Δ AZIMUTH controls to their detent positions.

f. On the indicator panel, press the RESET switch to return the SECONDS timer to zero. The radar equipment is now prepared for the next mission.

g. If the RANGE SELECTOR switch on the indicator panel is in the 10000 M position, set the EXPANDED SWEEP DELAY switch so that the bright band on the B-scope includes the approximate position of the target, as shown in figure 27. Turn the LOWER BEAM RANGE control on the computer panel to set the range strobes within the bright band. To expand the bright band over the entire area of the screen, turn the RANGE SELECTOR switch to the 2500 M position (fig. 28). (When the approximate position is known, it will be possible for the operator to expand the sweep before the target appears on the B-scope.) Note in figure 29 that the Δ time measurement becomes more important as the angle of elevation of the lower beam increases.

30. Single-Beam Extrapolation of a Low Angle Trajectory

By means of a modification to its electronic components, the AN/MPQ–4A radar may be used to locate weapons (such as howitzers) firing at low angles. The modification, when applied, permits the operator to select only the lower beam of the radar to detect projectiles traveling along low trajectories. The selection is made by means of a SINGLE-DUAL switch mounted on the computer front panel (fig. 30). When the SINGLE-DUAL switch is in the SINGLE position, the elevation of the lower edge of the lower beam is substituted for the elevation of the center of the lower beam, and the elevation of the upper edge of the lower beam substituted for the elevation of the center of the upper beam. In this way, the portion of the projectile's trajectory within the lower beam is substituted for the portion of the projectile's trajectory between beam centers, and is the trajectory sample used to compute weapon location (fig. 31). When the SINGLE-DUAL switch is in the normal (DUAL) position, the modification has no effect on the normal operation of the equipment.

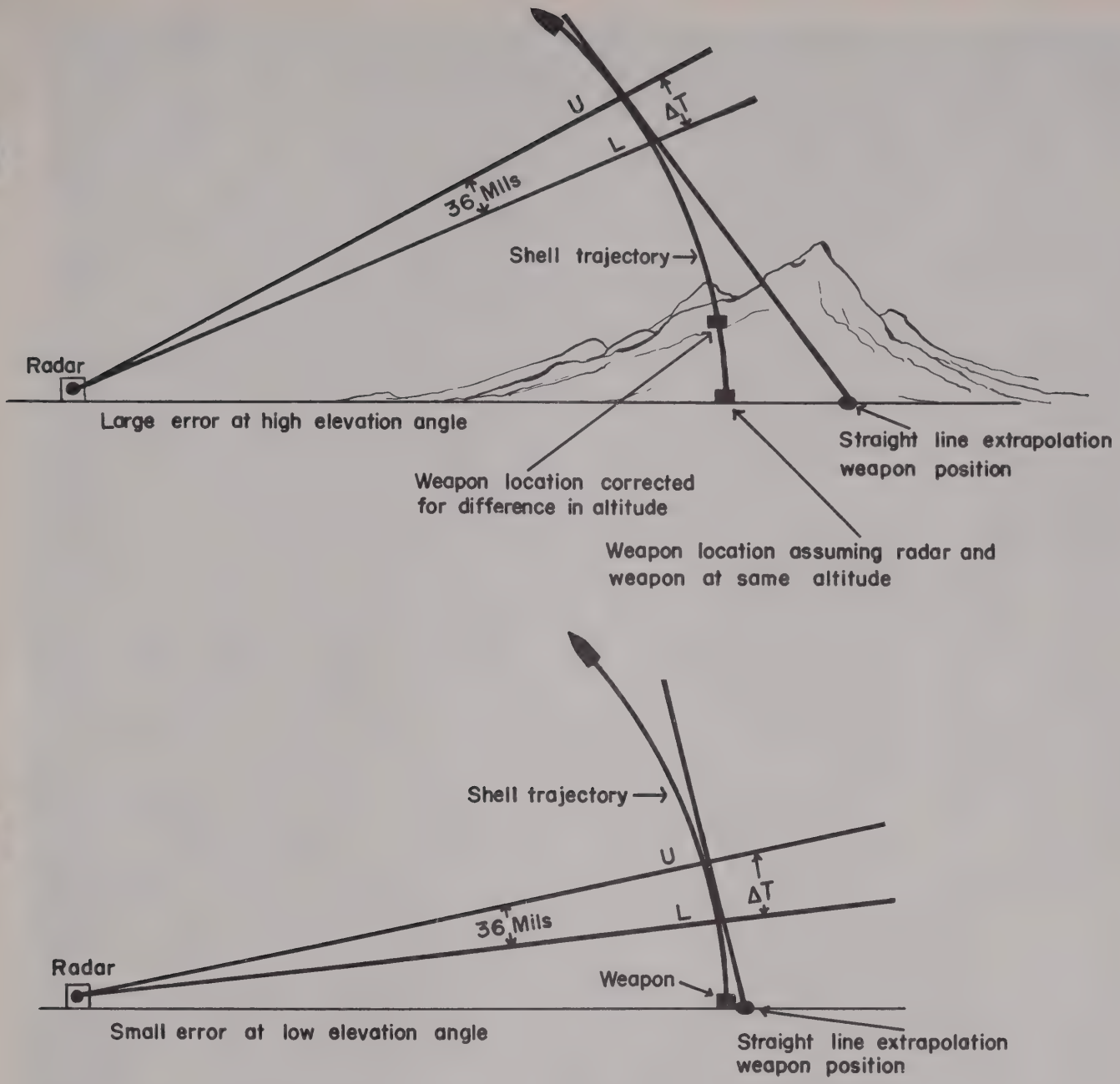

Figure 29. Effects of Δ time and difference in altitude on the weapon location.

31. Operating Procedures

a. When the presentation characteristic of a low-angle projectile appears on the B-scope (fig. 32), the operator:

(1) Marks each end of the lower beam presentation (fig. 33).

(2) Sets the SINGLE-DUAL switch to SINGLE.

(3) Turns off the RANGE SHIFT.

(4) Strobes the mark representing the lower beam entry point (beginning of the presentation) using the lower beam handwheels (fig. 34).

(5) Strobes the remaining mark using the Δ azimuth and Δ range handwheels (fig. 35).

(6) Inserts the measured Δ time.

Note. If the Δ time has not been measured, an arbitrary Δ time of 0.6 seconds should be inserted.

(7) Reads the weapon location from the coordinate counters.

(8) Compensates for the difference in altitude between the radar and weapon locations in the same manner as for dual-beam locations.

(9) Resets the SINGLE-DUAL switch to DUAL.

b. When performing single-beam locations the scanning elevation should not exceed + 35 mils.

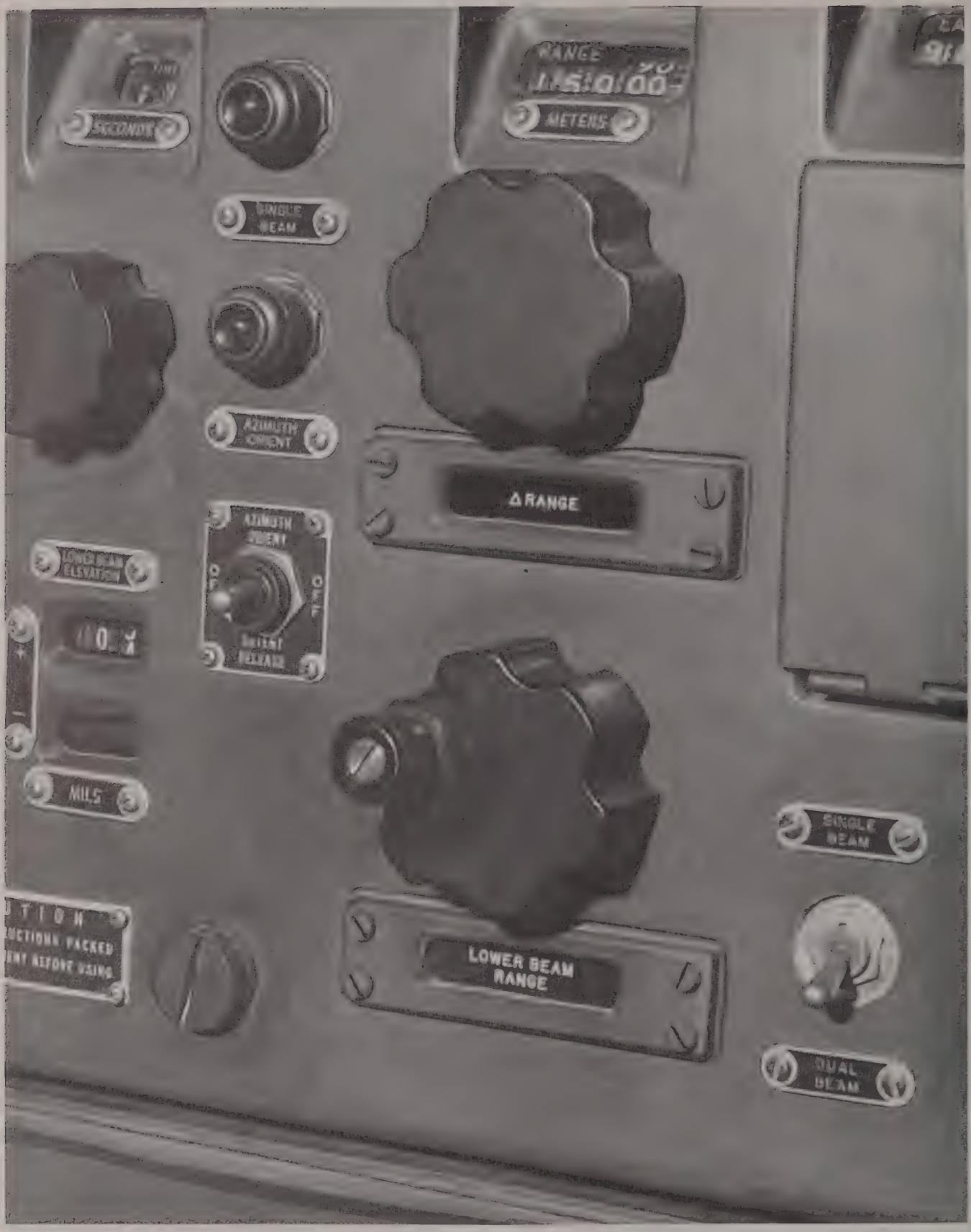

Figure 30. Partial view of the radar data computer panel.

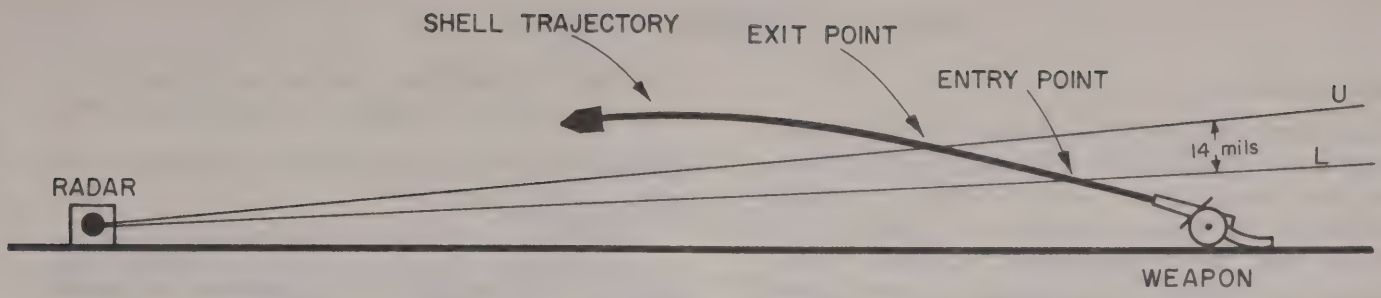

Figure 31. Detection of a projectile traveling along a low-angle trajectory.

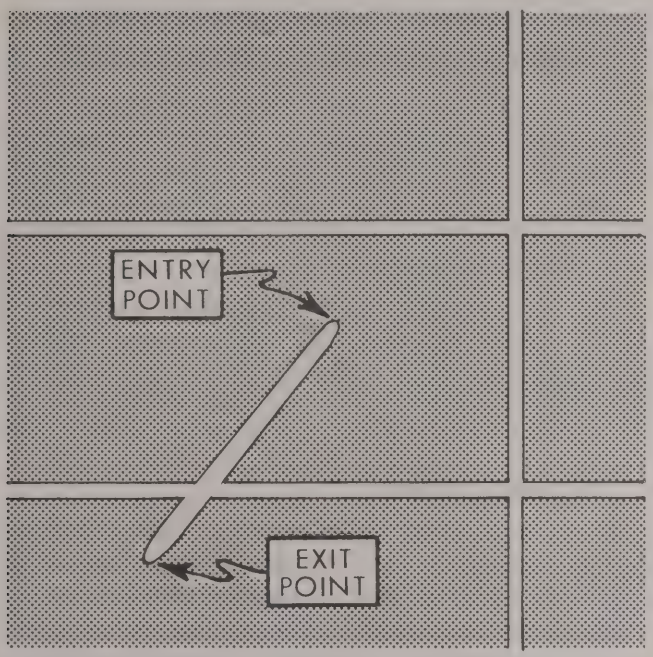

Figure 32. B-scope presentation of a low-angle projectile.

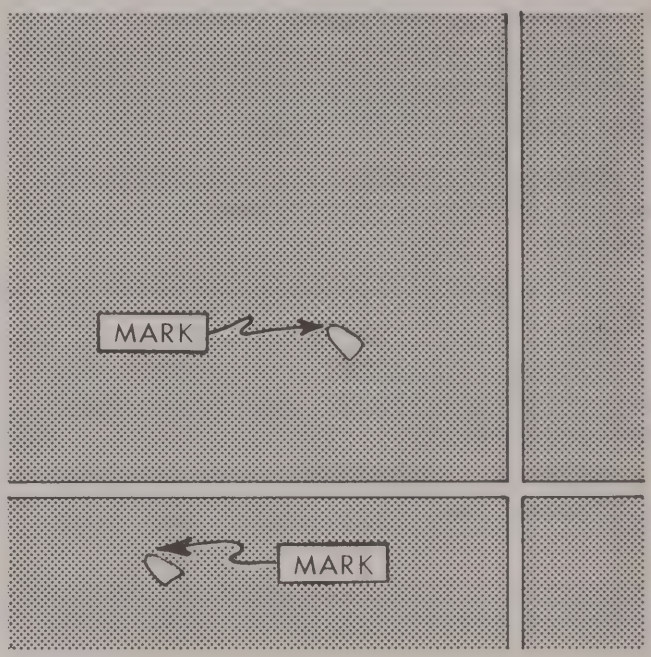

Figure 33. B-scope presentation with entry and exit points marked, SINGLE-DUAL switch set at SINGLE, and RANGE SHIFT off.

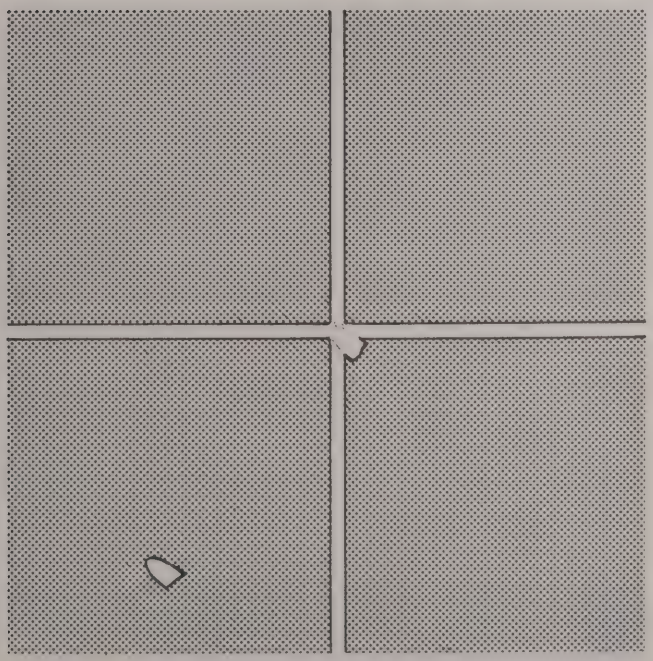

Figure 34. Strobing the entry point.

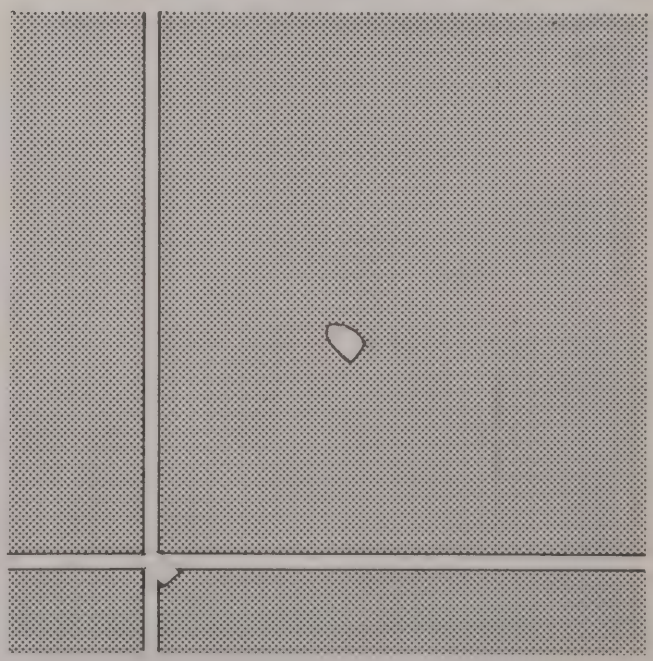

Figure 35. Strobing the exit point.

Section III. IMPACT LOCATION

32. General

The radar set AN/MPQ–4A may be used to compute the impact location of a mortar or high-angle artillery round. The observed presentation will be identical with the scope pattern in figure 24 or 28 except that the projectile will be moving downward and, therefore, the upper beam echo will appear first on the B-scope.

33. Computing the Impact Location

a. Rotate the LOWER BEAM RANGE control until the lower range strobe intersects the second (lower beam) mark on the B-scope.

b. Rotate the LOWER BEAM AZIMUTH control until the azimuth strobe intersects the lower beam mark.

c. Set the DETENT switch to DETENT RELEASE.

d. Rotate the Δ RANGE control until the upper range strobe intersects the first (upper beam) mark on the B-scope.

e. Rotate the Δ AZIMUTH control until the azimuth strobe intersects the first (upper beam) mark.

f. Rotate the Δ TIME control until the time lapse between the two echoes appears on the Δ TIME counter.

g. Read the WEAPON LOCATION EASTING and NORTHING counters to obtain the uncorrected grid cordinates of the point of impact. The uncorrected polar coordinates of the point of impact can be read on the RANGE and AZIMUTH counters.

h. Correct the inital coordinates for altitude, using the procedure described in paragraph 29*a*.

i. Make sure that the DOUBTFUL SOLUTION indicator lamp is off.

Note. This lamp illuminates when the precision of the weapon location is in excess of 50 meters. If the lamp illuminates, the accuracy of the weapon location is questionable.

j. Read and record the final values on the WEAPON LOCATION EASTING and NORTHING counters for the location of the point of impact.

k. Place the DETENT switch in the OFF position.

l. Reset the Δ RANGE and Δ AZIMUTH controls to their detent positions.

m. On the indicator panel, press the RESET switch to return the SECONDS timer to zero. The radar equipment is now prepared for the next mission.

34. Recording Form

DA Form 6–6 (Record of Sound, Flash, and Radar Locations) is used to record the information pertaining to a weapon location. This form facilitates the recording and reporting of pertinent target information. No spaces are provided on the form for recording the azimuth and range to the enemy weapon; however, when the radar set AN/MPQ–4A is operated from an assumed grid, the azimuth and range to the weapon must be recorded for use in determining the corrected coordinates when survey control is provided.

CHAPTER 5
RADAR GUNNERY

Section I. REGISTRATIONS

35. Purpose

a. The firing tables used by artillery units are based on a set of standard conditions of weather (closely approximating the average weather conditions in the North Temperate Zone of the earth) and on a set of standard conditions of materiel. If all conditions of weather and materiel were standard and there were no errors in survey or in the firing chart, a projectile would achieve the standard range defined in the appropriate firing table and burst on the gun-target line. However, standard conditions of weather and materiel seldom exist simultaneously; therefore, a projectile rarely (if ever) hits the target when a weapon is fired with only standard firing table data. Nonstandard atmospheric conditions, nonstandard materiel, or errors in survey or in the firing chart may cause inaccuracy in firing. The distance by which a projectile misses the target is caused by the combined effects of these errors. The total error and the corrections for it can be determined by registration.

b. In order to determine the corrections to compensate for nonstandard conditions, it is necessary to know where the rounds "did hit" when they were fired with a certain deflection, fuze setting, and quadrant elevation. The "did hit" location can be compared with the location where the rounds should have hit if all conditions had been standard. The difference between the "should hit" location and the "did hit" location can be converted to corrections by established procedures.

c. A mean-point-of-impact (MPI) or high-burst (HB) registration normally is faster and more economical than a precision registration conducted by a ground observer. From six usable observed rounds fired in a high-burst registration, the fire direction center (FDC) can determine the corrections to the firing data for deflection, fuze setting, and quadrant elevation. In a mean-point-of-impact registration, the same number of usable rounds is fired, but fuze quick is used; therefore, the correction for the fuze setting cannot be determined. Normally, the FDC will fire a high-burst registration when fuze time is available and its use is anticipated for subsequent fire missions in the area.

36. Radar as the Observer

The AN/MPQ–4A radar section is often required to observe high-burst and mean-point-of-impact registrations. The radar section should have direct communications with the FDC at all times. The radar section can complete a registration quickly, even during periods of poor visibility when ground observation is ineffective.

37. Radar-Observed High-Burst Registration

a. A high-burst registration is fired with fuze time. The high burst must be high enough in space that the burst can be observed through the optical telescope. The radar section is alerted to observe a high-burst registration by a "message to observer". This message must be expeditiously prepared by the FDC and sent to the radar. The radar section immediately plots the coordinates announced in the message to observer.

b. The message to observer, which is a standard message, consists of six elements and should be transmitted to the radar section in the following sequence:

(1) *Warning order.* The first element must always be sent. It consists of the order OBSERVE HIGH BURST. This warning order informs the radar section of the type of registration to be fired and directs the radar crew to immediately begin preparations to observe.

(2) *Unit to fire.* The second element consists of the word FOR followed by the call sign or code name of the unit to fire. The second element may be omitted by SOP when it is unnecessary for the

RADAR OBSERVED HIGH-BURST OR MEAN- POINT-OF-IMPACT (DATUM PLANE) REGISTRATION

For use of this form, see FM 6-161; the proponent agency is United States Continental Army Command.
SEE NOTES ON REVERSE.

STEP 1: MESSAGE TO OBSERVER

1. OBSERVE (CHECK APPLICABLE BOX) ☒ HB ☐ MPI
2. FOR (UNIT OR CALL SIGN): Loud Thunder 18
3. AT GRID: 6400 3900
4. MINIMUM ACCEPTABLE ALTITUDE (HB): 395
5. REPORT ALTITUDE (HB):
6. REPORT WHEN READY TO OBSERVE:

STEP 2: INITIAL POINTING DATA

7. AZ (NEAREST 1 MIL) (NOTE 1): 1634 + 40 = 1674
8. RANGE (NEAREST 10 METERS): 6110
9. ELEVATION TO SCREENING CREST: +16
10. + 10 MIL: +10
11. ELEVATION (NEAREST 1 MIL) (9 + 10): +26 + 7 = +33

STEP 3: INITIAL REGISTRATION POINT ALTITUDE

NOTE: STEP 3 HB ONLY

12. RANGE (8) (IN THOUSANDS): 6.11
13. ELEVATION (11): +26
14. VI (12 X 13): +159
15. ALTITUDE (RADAR) (METERS): 326
16. ALTITUDE (RP) (14 + 15): 485

STEP 4: REPORT TO FDC

ALTITUDE (16) (HB): 485 ; ATMY COMMAND; REQUEST SPLASH; READY TO OBSERVE

STEP 5: RECORDING AND COMPUTATION

RD NO	FROM B SCOPE: RANGE	FROM B SCOPE: AZIMUTH	FROM TELESCOPE (HIGH BURST ONLY): AZIMUTH DEVIATION (NOTE 3): LEFT (–)	AZIMUTH DEVIATION (NOTE 3): RIGHT (+)	ELEVATION DEVIATION: BELOW (–)	ELEVATION DEVIATION: ABOVE (+)
1	6300	1675		40		7
IF REQUIRED, ADJUST POINTING DATA AND CORRECT BLOCKS 7 AND 11 (NOTE 2)						
2	6280	1676		4	6	
3	6250	1672		5	5	
4	6340	1680		7		1
5	6320	1677	7		0	0
6	6290	1675		2	2	
7	6000	1650	25			19
8	6220	1680		5	6	
TOTAL	17: 37700	18: –	TOTAL LEFT (–): 7	TOTAL RIGHT (+): 23	TOTAL BELOW (–): 19	TOTAL ABOVE (+): 1

NOTE: AFTER SIX VALID ROUNDS, REPORT "END OF MISSION" TO FDC

19. AZIMUTH DEVIATION = ALGEBRAIC TOTAL LEFT (–) AND RIGHT (+): +16

20. ELEVATION DEVIATION = ALGEBRAIC TOTAL BELOW (–) AND ABOVE (+): -18

23. REGISTRATION POINT RANGE (NEAREST 10 METERS): 6 | 37700 (17) = 6283

24. AZIMUTH OF MPI (NEAREST 1 MIL): 6 | (18)

21. 6 | +16.0 (19) = +2.6

22. 6 | -18 (20) = ± -3

25. (21) (NEAREST 1 MIL): +3

27. (22) (NEAREST 1 MIL): -3

26. (7): 1674

28. (11): +33

29. HB AZ (ALGEBRAICALLY ADD 25 AND 26): 1677

30. HB ELEV (ALGEBRAICALLY ADD 27 AND 28): +30

STEP 6: FINAL REGISTRATION POINT ALTITUDE

31. RP RANGE (23) (IN THOUSANDS): 6.28
32. HB (ENTER VALUE BLOCK (30)) MPI (ENTER VALUE BLOCK (11)): +30
33. VI (31 X 32): + 188
34. ALTITUDE RADAR: 326
35. ALTITUDE RP (33 + 34): 514

STEP 7: REPORT TO FDC

36. REPORT ON RADAR OBSERVED (CHECK APPLICABLE BOX) ☒ HB ☐ MPI
37. TIME OBSERVED: 261500
38. DIRECTION (MPI (24); HB (29)) (SEE NOTE 4): 1677
39. DISTANCE (SEE NOTE 4): 6280
40. ALTITUDE (35) (SEE NOTE 4): 514
41. GRID OF RP (NEAREST 10 METERS): 6422 3925

DA FORM 1 JUL 69 2888 REPLACES EDITION OF 1 JAN 65, WHICH WILL BE USED.

Front

Figure 36. DA Form 2888 showing a completed high-burst registration.

NOTES

NOTE 1 – *(High Burst Only)* The telescope must be pointed at the pointing azimuth. To accomplish this, place the DETENT switch in the AZIMUTH ORIENT position. Apply *(add or subtract as necessary)* the field correction to the chart azimuth. Then, move the antenna in azimuth until the AZIMUTH counter indicates the corrected value. Record the chart azimuth in block 7.

NOTE 2 – If the burst from the first round appears above the horizon but is not seen on the B-scope, the pointing angle of elevation must be changed to cause the next round to burst in the radar beam. The antenna may also have to be moved in azimuth to cause the burst to appear in the center of the telescope. When the antenna is moved in either azimuth or elevation, the new pointing data must be entered in the appropriate block under step 2. If the first round bursts more than 5 mils below the center of the telescope, the FDC must be notified *(BURST TOO LOW, REQUEST ALTITUDE INCREASE)*. The antenna should not be depressed.

NOTE 3 – *(High Burst Only)* If the B-scope azimuth disagrees with the telescope azimuth more than ± 10 mils, an error has been made in spotting, marking, or strobing the echo on the B-scope. Therefore, the data to the round will not be valid.

NOTE 4 – The average azimuth, range, and altitude must be computed independently by two crew members. Insert the average azimuth and range into the computer. Record the resulting grid coordinates in block 41, DA Form 2888. Polar plot the average range and azimuth on the radar chart and record the resulting grid coordinates. These two sets of coordinates should agree with each other within 20 meters in easting and 20 meters in northing.

Back

Figure 36—Continued.

radar section to contact the battery that is to fire or to know the battery location.

(3) *Location.* The third element consists of the word GRID followed by the grid coordinates. It specifies the military grid reference (to the nearest 10 meters) of the point to which data are obtained. The third element must always be sent.

(4) *Minimum altitude.* The fourth element consists of the phrase MINIMUM ALTITUDE followed by the altitude (in meters) below which the high burst should not be selected. This altitude is determined by the fire direction center. When computing the minimum altitude, the FDC must consider the height-of-burst probable error.

(5) *Altitude report.* The fifth element consists of the words REPORT ALTITUDE. It requires the radar section to inform the FDC of the altitude of the high burst.

(6) *Report order.* The sixth element consists of the words REPORT WHEN READY TO OBSERVE.

c. The message to observer received by the radar section is copied in the spaces provided on DA Form 2888, Radar-Observed High-Burst or Mean-Point-Of-Impact (Datum Plane) Registration, (fig. 36). DA Form 2888 may be requisitioned through normal supply channels.

d. The radar plotter determines the pointing azimuth and the pointing range, which are the direction and distance from the radar to the announced location of the high burst. The angle of elevation to the screening crest along the pointing azimuth is determined by observation through the telescope; then, the pointing elevation is computed by adding 10 mils to the angle of elevation. The radar set is oriented on the pointing azimuth, range, and elevation. This information is recorded on DA Form 2888.

Note. Fifty meters above the ground usually is a good height of burst for a high burst registration.

e. In order to complete the computations of firing data to send to the battery to fire, the FDC must know the location of the announced high burst. Therefore, as soon as the radar plotter has computed the pointing data, he determines the altitude and transmits it to the fire direction center. The altitude of the point selected for a high-burst registration is computed on DA Form 2888 and is determined in the following manner:

(1) Multiply the pointing range (divided by 1,000 to the nearest 10 meters) by the pointing elevation. The product is the vertical interval between the radar and the high burst in meters. This step may be performed by simple multiplication in the space provided on the registration form.

(2) Add the vertical interval obtained in (1) above to the altitude of the radar in meters. The sum is the predicted altitude of the announced high-burst location.

(3) If the predicted altitude is above the minimum altitude given in the message to observer, send the message ALTITUDE (so much) to the fire direction center.

(4) If the computed altitude is below the minimum altitude, use the minimum altitude. However, a new pointing elevation must be computed to point the radar antenna at the minimum altitude. This computation is performed in the following manner:

(*a*) Subtract the altitude of the radar from the minimum altitude. The difference is the vertical interval.

(*b*) Divide the vertical interval by the pointing range (divided by 1,000 to the nearest 10 meters). The result is the angle of elevation. This value rounded to the nearest mil is the new pointing elevation.

f. When the radar section has completed all preparations to observe the registration, the message ALTITUDE (so much), REQUEST SPLASH, AT MY COMMAND, READY TO OBSERVE is sent to the fire direction center. This message informs the FDC of three things. First, it notifies the FDC that the radar section desires a splash warning from the FDC is sent 5 seconds before the round is due to burst. Second, it notifies the FDC that the radar section will control the fires of the firing battery; the term AT MY COMMAND means that the weapon will fire at the command of the radar section. Third, it informs the FDC that the radar section has completed all preparations and is ready to observe the registration.

g. When the radar section is notified that the weapon is ready to fire, the radar plotter sends the command to fire the first round. When the weapon has fired, the FDC transmits SHOT, OVER to the radar section. The radar plotter acknowledges the report by transmitting SHOT, OUT to the fire direction center. Five seconds before the round is due to burst, the FDC transmits SPLASH, OVER to the radar section. The radar plotter acknowledges this report by transmitting SPLASH, OUT to the fire direction center. When the radar section is ready for another round, it sends the command REPEAT to the fire direction center. The first round fired in a high-burst registration normally is considered an orienting round, and the radar crew may have to reorient the antenna on the actual burst point of the round. If it is necessary to reorient the antenna, the command REPEAT is delayed until the antenna has been reoriented. For subsequent rounds, the command REPEAT may be transmitted immediately after the battery announces SHOT.

h. This procedure is continued until the radar section has observed and recorded on DA Form 2888 the data for six usable rounds.

i. The radar can provide the location of the high-burst either by grid coordinates and altitude; by direction, distance, and altitude from the radar to the high burst; or by direction, distance, and vertical angle to each round of the high burst. There is no difference in the accuracy of these three methods; however, the coordinates and altitude method is fastest, does not require that the radar be plotted on the firing chart, and is the preferred method of reporting. After the registration has been observed and it has been determined that no erratic round has occurred, the radar section transmits END OF MISSION to the fire direction center.

38. Marking and Strobing Target Echoes for High-Burst Registration

a. The success of any radar-observed registration depends on the accuracy of the marking and strobing of the target echo on the B-scope. In a high-burst registration, the range and azimuth are determined by strobing. Azimuth strobing provides a check on the azimuth deviations reported by the telescope observer.

b. A high-burst round is not considered valid unless the initial echo appears as shown in figure 38. Adjustments of the pointing elevation must be continued until the echoes appear.

c. The operator must know the point at which to strobe each round and how to mark the echoes to locate this point. The echo for a round fired in a high-burst registration first appears on the B-scope as shown in figure 37. It is then marked and strobed as shown in figures 38 and 39.

Note. In order to insure an accurate mark, the B-scope GAIN and INTENSITY controls must be properly adjusted.

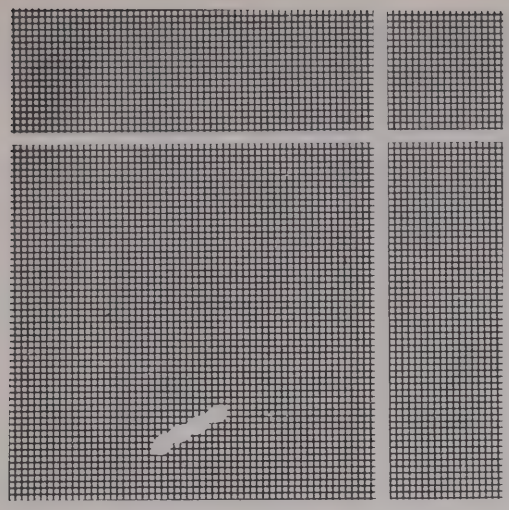

Figure 37. Projectile first entering the beam (HB).

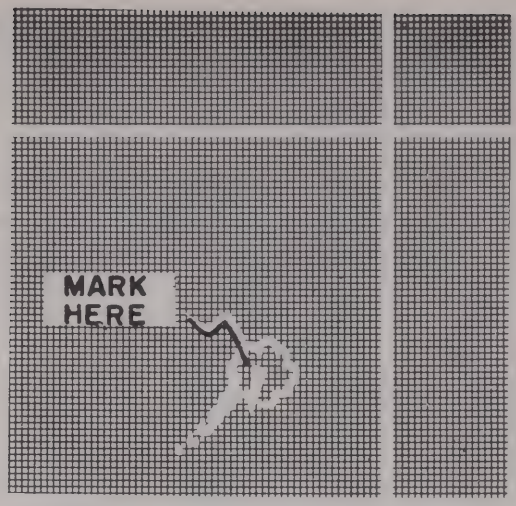

Figure 38. Projectile bursting in the beam (HB).

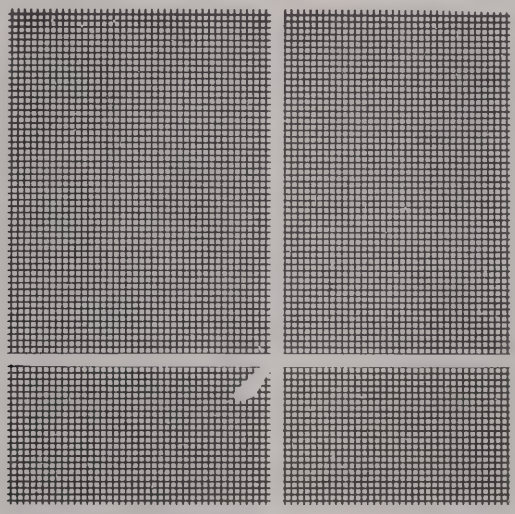

Figure 39. Strobing a marked burst (HB).

39. Conduct of a High-Burst Registration

a. General. Before the radar set can be considered ready to observe a registration, it must be emplaced and checked by the most accurate procedures possible. A registration can be accurately observed only if the radar set has been leveled, collimated, oriented, and range calibrated and the accuracy of the computer has been verified. All performance checks must be within the prescribed tolerances.

b. Personnel. Four members of the radar section are needed to conduct a radar-observed high-burst registration. Their duty assignments are—

(1) Control unit operator.

(2) Radar plotter.

(3) Telescope observer.

(4) Recorder.

c. Sequence. When the radar section receives the message to observer, all members of the section start preparations immediately. A detailed explanation of the duties of each member is given for each of the following five phases of the registration:

(1) Preparation.

(2) Reorientation.

(3) Observation.

(4) Computation.

(5) Reporting.

d. Preparation. The preparation phase begins when the radar section receives the message to observer and ends when the section reports READY TO OBSERVE. An example problem used to explain the duties of personnel is shown on DA Form 2888 (fig. 36). The notes on the reverse side of DA Form 2888 should be reviewed

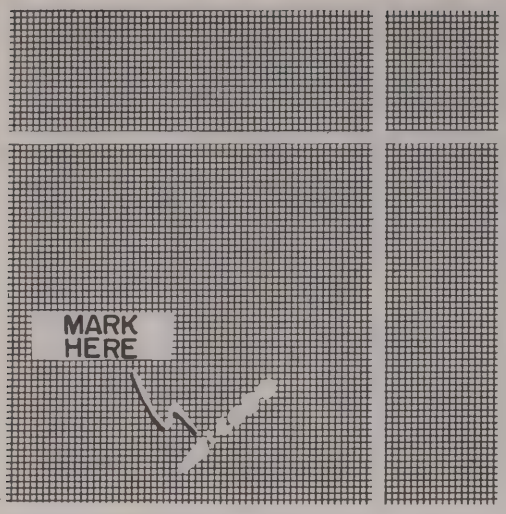

Figure 40. Marking the point where the projectile enters the beam (MPI).

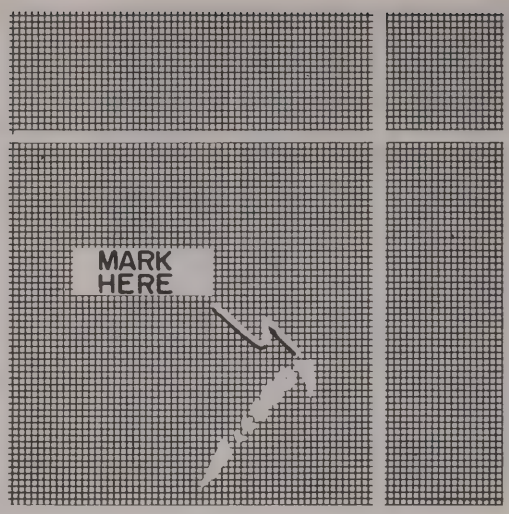

Figure 41. Marking the point where the projectile leaves the beam (MPI).

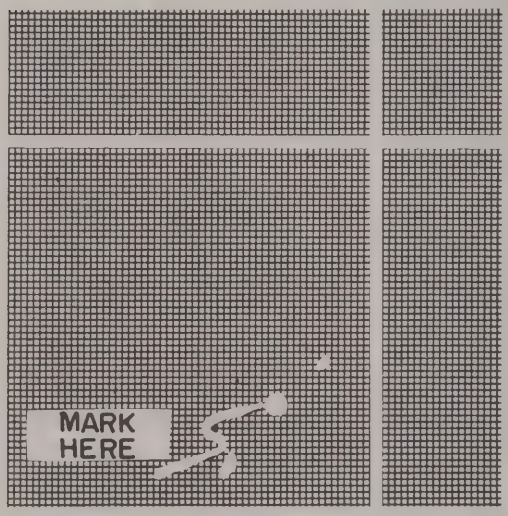

Figure 42. Marking the point where the projectile passed through the center of the beam.

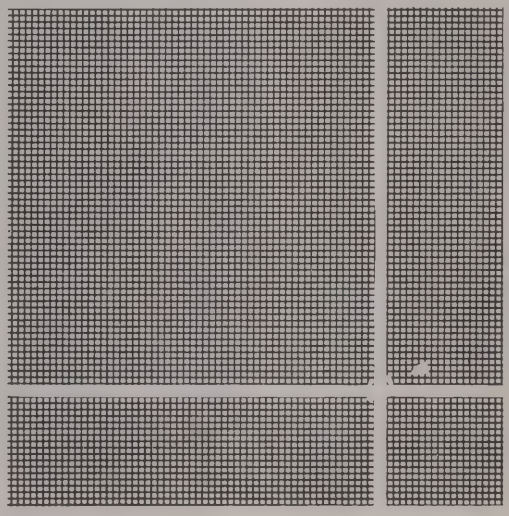

Figure 43. Strobing the midpoint.

before proceeding. The duties of personnel during the preparation phase are outlined in (1) through (4) below.

(1) The *radar plotter*—

(*a*) Records the message to observer in step 1 on DA Form 2888 as shown in figure 36.

(*b*) Plots the coordinates given in the message to observer on the radar chart.

(*c*) Measures the azimuth and range to the announced high-burst location and announces aloud the following data: AZIMUTH 1634 (always read to the nearest mil). RANGE 6110 (always read to the nearest 10 meters).

(*d*) Records the announced azimuth and range as the pointing azimuth and range in step 2, blocks 7 and 8, on the registration form.

(*e*) Records in block 9 the angle of elevation announced by the telescope observer. He adds to the angle of elevation the 10 mils already recorded in block 10 and records the sum, to the nearest mil, in block 11 as the pointing elevation.

Note. At this point block 11 indicates only the sum of the screening crest plus 10 mils; i.e., 26 mils. The additional 7 mils indicated in block 11 on the form is the deviation, which will not become known until after the registration begins.

(*f*) In the blocks for step 3 on the registration form, computes the altitude of the high burst.

(*g*) After all members of the radar section have reported ready, reports to FDC (step 4): ALTITUDE (from block 16), AT MY COMMAND, REQUEST SPLASH, READY TO OBSERVE.

(2) The *control unit operator*—

(*a*) Orients the radar optical axis (telescope) on the pointing azimuth in the following manner:

1. When the pointing azimuth is announced by the plotter, adds or subtracts the measured field correction to the pointing azimuth. The sum is the AZIMUTH counter reading that must be set on the computer panel in order to orient the telescope (the optical axis) on the pointing azimuth.

2. Moves the telescope to the pointing azimuth by placing the DETENT switch in the AZIMUTH ORIENT position and setting the azimuth controls in detent. Using the AZIMUTH switch on the control-power supply panel, traverses the antenna until the AZIMUTH counter on the computer panel indicates the value of the chart azimuth with the field correction algebraically added.

Caution: Fine adjustments are made with the azimuth handwheel on the radar trailer frame to prevent damage to the azimuth brake.

(*b*) Prepares the computer and indicator panels by—

1. Placing the DETENT switch in the OFF position and locking the upper beam controls.

2. Placing the BEAM VIDEO selector switch in the LOWER position.

3. Placing the RANGE SHIFT switch in the OFF position.

4. Placing the RANGE SELECTOR switch in the 2500 M position.

5. Placing the EXPANDED SWEEP DELAY switch to the appropriate position. The expected range to the burst should be near the center of the 2,500-meter scope.

(3) The *telescope observer*—

(*a*) Assists the control unit operator in orienting the telescope on the pointing azimuth by rotating the azimuth handwheel on the radar trailer frame to make fine adjustments in azimuth.

Note. The telescope is positioned on the pointing azimuth by rotating the antenna until the high-burst chart azimuth appears on the antenna azimuth counter on the radar frame.

(*b*) Measures the angle of elevation to the screening crest and reports it to the radar plotter after the telescope has been oriented on the pointing azimuth. To determine the elevation angle, he sets the elevation counter to zero and reads the angle to the screening crest by using the telescope mounted on the radar trailer.

(4) *The recorder*—

(*a*) Enters all known data on the registration (form (fig. 36) and checks the altitude computations performed by the radar plotter. The registration form completed by the recorder can be used to doublecheck the computations of the radar plotter.

(*b*) Checks the field correction at the echo box.

(*c*) Insures that the correct reading is set on the elevation counter at the radar trailer when the antenna is set on the pointing elevation.

(*d*) Checks the level of the radar set.

e. Reorientation. The reorientation phase begins when the radar section receives the message SHOT for the first round in the mission. It ends when the deviations of the burst can be read from the telescope and the burst of the projectile appears and is marked on the B-scope (fig. 38). The duties of personnel during the reorientation phase are outlined in (1) through (4) below:

(1) The *telescope observer*—

(*a*) Takes a position to observe through the telescope.

(*b*) Looks for the burst through the scope when SPLASH is received.

(*c*) Immediately spots the deviation in mils from the center of the telescope to the point of the burst when the burst appears.

Note. The observer cannot stand behind the telescope, but must stand to the side. Therefore, care must be taken to insure that spotting is correct.

(*d*) Reports the deviation in mils to the recorder and insures that the recorder and the radar plotter announce the azimuth and elevation deviations and record them in the appropriate columns in step 5 on their DA Forms 2888.

Note. If the burst from the first round does not appear on the B-scope as shown in figure 38, the observer reorients the antenna in azimuth. He uses the azimuth handwheel on the radar trailer to set the new pointing azimuth announced by the recorder.

(2) *The recorder*—

(*a*) Records and announces the azimuth and elevation deviations for each round in the appropriate columns in step 5 on the registration form.

(*b*) Calculates the new pointing azimuth and pointing angle of elevation required to cause the round to burst in the beam, if the burst from the first round does not appear on the B-scope as

shown in figure 38. If the burst was to the left of the center of the telescope, he subtracts the amount of the deviation reported by the telescope observer from the pointing azimuth to obtain a new pointing azimuth. If the burst was to the right of the center of the telescope, he adds the amount of the deviation reported by the telescope observe to the pointing azimuth to obtain a new pointing azimuth. If the burst was above the center of the telescope, he adds the amount of the deviation reported by the telescope observer to the pointing angle of elevation to obtain a new pointing angle of elevation. If the burst was below the center of the telescope(he substracts the amount of the deviation reported by the telescope observe from the pointing angle of elevation to obtain a new pointing angle of elevation.

(*c*) Moves to the radar data computer panel when the new pointing azimuth and pointing angle of elevation have been set. He insures that the new pointing azimuth appears on the AZIMUTH counter and that the new pointing elevation appears on the ELEVATION-DEPRESSION counter.

(*d*) Enters the new pointing azimuth and elevation on the registration form.

(3) The radar plotter records in step 5 on the registration form the range and azimuth announced by the control unit operator and the azimuth and elevation deviations reported by the telescope observer.

(4) *The control unit operator*—

(*a*) Watches for the appearance of the echo on the B-scope of the first round when SPLASH is received.

(*b*) Marks and strobes the burst location.

(*c*) Announces the azimuth and range to the radar plotter.

(*d*) Corrects the elevation of the antenna to the new pointing elevation announced by the recorder if the burst of the projectile does not appear on the B-scope.

(5) During the reorientation phase, the antenna is never lowered. The initial data require setting the elevation at 10 mils above the screening crest. If the antenna is lowered, the beam may be blocked by the screening crest. If the first angle of elevation reported by the recorder is more than 5 mils below the initial pointing elevation, the round will not be used for reorientation or reporting. When the angle of elevation reported is more than 5 mils below the initial pointing elevation, the radar plotter notifies the FDC by transmitting BURST TOO LOW, REQUEST ALTITUDE INCREASE.

(6) In the registration recorded on DA Form 2888 (fig. 36) the telescope deviations reported by the observer were RIGHT 40, ABOVE 7. The data reported by the control unit operator from the B-scope were RANGE 6300, AZIMUTH 1675. The initial pointing data recorded in step 2 were changed as shown in figure 36.

f. Observation. The observation phase begins when the reorientation phase has been completed and ends when END OF MISSION is announced. The duties of personnel during the observation phase are described in (1) through (4) below.

(1) *The control unit operator*—

(*a*) Watches the B-scope for the appearance of the echo as SPLASH is received for each round.

(*b*) Marks and strobes the echo.

(*c*) Announces the range and azimuth to the radar plotter.

(*d*) Reports LOST if the round is not observed. If the round does not burst in the beam of the radar, it cannot be used in registration.

(2) *The telescope observer*—

(*a*) Takes a position to observe through the telescope when SHOT is received.

Note. The observer must not stand erect in the radar beam. He should kneel down away from the beam and not raise his head above the level of the telescope.

(*b*) Looks for the burst through the telescope when SPLASH is received.

(*c*) Announces the azimuth deviation as LEFT or RIGHT (so much) and the elevation deviation as ABOVE or BELOW (so much) when the burst appears.

(*d*) Announces LOST if he does not observe the round.

(3) The recorder records on the registration form the azimuth and elevation deviations announced by the telescope observer and insures that the information is received by the radar plotter.

(4) The *radar plotter*—

(*a*) Records the range and azimuth announced by the control unit operator.

(*b*) Records the azimuth and elevation deviations announced by the recorder.

(*c*) Compares the azimuth announced by the recorder to the azimuth announced by the control unit operator. The two azimuths must agree within $\pm$ 10 mils. If they do not agree, he checks to determine if an error has been made. If necessary, he requires an additional round to be fired.

The radar officer or the chief of section will determine when the data have been recorded for six usable rounds.

(5) When the data have been recorded for six usable rounds, END OF MISSION is transmitted to the fire direction center.

g. Computation. The computation phase begins when the possibility of erratic rounds has been eliminated. During this phase, both the plotter and recorder perform the computations required. Each member works independently of the other. Then they compare results when the totals are determined; when the final range, azimuth, and elevation are determined; when the altitude is computed; and immediately before the report is sent to the fire direction center. The high-burst location is computed on the DA Form 2888 as follows:

(1) The ranges from the RANGE counter on the computer panel are added, and the total is recorded in block 17.

(2) The azimuth and elevation deviations are totaled (blocks 19 and 20).

(3) The totals obtained by the plotter are compared with those obtained by the recorder. If the totals do not agree, the error must be found before the computation is continued.

(4) In a high-burst registration, the azimuths from the AZIMUTH counter on the computer panel are not totaled. These azimuths are used only during the observation phase for comparison with the azimuth computed from the telescope observer's deviations.

(5) The totals are divided by the number of usable rounds to determine the average range (block 23), the average azimuth deviation (block 21), and the average elevation deviation (block 22).

(6) The average range is the *range to the high burst* (block 31).

(7) The average deviation is algebraically added to the final pointing azimuth (block 7), using blocks 25 and 26. The result is the high-burst azimuth (block 29).

(8) The average elevation deviation is algebraically added to the final pointing elevation (block 11), using blocks 27 and 28. The result is the high-burst elevation (block 30).

(9) The high-burst range, azimuth, and elevation obtained by the plotter are compared with those obtained by the recorder. If the values do not agree, the work is recomputed until the error is corrected.

(10) The high-burst altitude is computed by multiplying the high-burst elevation (block 30) by the high-burst range (block 23) in thousands and adding the product to the altitude of the radar as shown in step 6 on the registration form.

(11) The high-burst altitude (block 35) computed by the plotter is checked with that computed by the recorder. If the values do not agree, the work is recomputed until the error is found.

h. Reporting.

(1) When the computations made by the plotter and those made by the recorder have been compared and found to agree, the location of the high-burst is transmitted to the FDC as grid or polar plot coordinates. This report consists of the following six elements, transmitted in the order in which they are listed:

(*a*) REPORT ON RADAR-OBSERVED HIGH BURST—Informs the FDC of the type of message to follow.

(*b*) TIME OBSERVED—Provides the FDC and the radar section with a message number for future reference to the registration. It is the approximate time at which the firing was completed.

(*c*) DIRECTION—The azimuth from the radar antenna to the high-burst location.

(*d*) DISTANCE—The range from the radar antenna to the high-burst location.

(*e*) ALTITUDE—The computed altitude of the high-burst location.

(*f*) GRID—The computed grid coordinates of the high-burst location.

(2) Both computers record the report to the FDC in step 7 on the registration form. The radar plotter transmits the message to the FDC. The recorder listens as it is transmitted to insure that no errors are made.

40. Radar-Observed Mean-Point-of-Impact Registration

a. A mean-point-of-impact (MPI) registration is fired with fuze quick. However, the projectiles may not be observed at impact, because the radar will normally be sited behind a mask. The registrations will be observed at a selected datum plane (SDP). A datum plane is a plane in space through which all rounds pass that are fired during the conduct of the MPI registration. It may be construed to be an imaginary hilltop or a mound of dirt on which the rounds actually impact. The selected

datum plane is the plane where all rounds in the registration pass through the center of the lower beam. The use of the optical telescope is not required. All information is determined by strobing the point where each round passed through the center of the lower beam.

b. The radar section is alerted to observe a mean-point-of-impact registration by a message to observer. The message to observer for a mean-point-of-impact registration parallels that for a high-burst registration except that the minimum altitude is omitted.

c. The procedures for determining the pointing data are the same as those for a high-burst registration.

d. In the mean-point-of-impact registration, there is no requirement to reorient the radar, as the radar beam is sufficiently wide to insure the detection of all rounds.

e. The mean-point-of-impact registration also requires six usable rounds. The azimuth and range to each round are determined by strobing the center of the target echo on the B-scope.

f. The mean-point-of-impact location is sent to the FDC as it is sent for a high-burst registration.

41. Marking and Strobing Target Echoes for Mean-Point-of-Impact Registration

a. The accuracy of the mean-point-of-impact registration depends to a great extent on the procedure used in marking and strobing the echo on the B-scope. In the mean-point-of-impact registration, the azimuth and range are obtained from the B-scope.

b. The appearance of the echo for a mean-point-of-impact registration is similar to that for a high-burst registration, except that the round does not burst in the beam. The operator sees only a trace of light as the round passes through the lower beam. He marks the point of entry, follows the round until it disappears, and marks the point of exit. After marking the entry and exit points, the operator must interpolate and mark a point half-way between the entry and exit points. This center point is strobed for azimuth and range. The procedure is illustrated in figures 40 through 43.

42. Conduct of Mean-Point-of-Impact Registration

a. Preliminary checks and adjustments of the radar must be performed as they are for a high-burst registration.

b. Three members of the radar section are needed to conduct a mean-point-of-impact registration. They are the —

(1) Control unit operator.
(2) Radar plotter.
(3) Recorder.

c. When the radar section receives the message to observer, the procedures to be followed and the duties of the crew members are similar to those for a high-burst registration. Since the mean-point-of-impact registration is fired with fuze quick, the rounds cannot be observed through the telescope; therefore, the observer cannot report the deviations of the rounds. The range and azimuth to each round are determined from the B-scope. When six usable rounds have been detected, their ranges and azimuths are averaged to find the range and azimuth to the mean point of impact. The angle of elevation at which the rounds are observed is the pointing elevation. The duties of the crew members for a mean-point-of-impact registration will be discussed in phases paralleling those of a high-burst registration. Since the telescope is not used in a mean-point-of-impact registration, there is no reorientation phase. The data recorded throughout all phases of the registration are illustrated on the completed DA Form 2888 in figure 44. The phases of the registration are as follows:

(1) Preparation.
(2) Observation.
(3) Computation.
(4) Reporting.

d. Preparation. The preparation phase begins when the radar section receives the message to observer and ends when the radar section reports READY TO OBSERVE. The duties of the crew members during the preparation are as follows:

(1) The *radar plotter*—

(*a*) Records the message to observer on the DA Form 2888 as shown in figure 44.

(*b*) Plots on the radar chart the coordinates given in the message to observer.

(*c*) Measures the azimuth and range to the announced mean point of impact and announces aloud the following data: AZIMUTH 624 (always read to the nearest mil). RANGE 5410 (always read to the nearest 10 meters).

(*d*) Records the announced azimuth and range as the pointing azimuth and range in step 2, blocks 7 and 8 on DA Form 2888.

(*e*) Records in block 9 the angle of elevation announced by the recorder. He adds to the angle of elevation the 10 mils already recorded in

RADAR OBSERVED HIGH-BURST OR MEAN-POINT-OF-IMPACT (*DATUM PLANE*) REGISTRATION

For use of this form, see FM 6-161; the proponent agency is United States Continental Army Command. *SEE NOTES ON REVERSE.*

STEP 1: MESSAGE TO OBSERVER	STEP 2: INITIAL POINTING DATA	STEP 3: INITIAL REGISTRATION POINT ALTITUDE
1. OBSERVE (CHECK APPLICABLE BOX) ☐ HB ☒ MPI	7. AZ (NEAREST 1 MIL) (NOTE 1) 624	NOTE: STEP 3 HB ONLY.
2. FOR (UNIT OR CALL SIGN) Loud Thunder 28	8. RANGE (NEAREST 10 METERS) 5410	12. RANGE (8) (IN THOUSANDS)
3. AT GRID 5230 4860	9. ELEVATION TO SCREENING CREST +22	13. ELEVATION (11)
4. MINIMUM ACCEPTABLE ALTITUDE (HB)	10. + 10 MIL +10	14. VI (12 X 13)
5. REPORT ALTITUDE (HB)	11. ELEVATION (NEAREST 1 MIL) (9 + 10) +32	15. ALTITUDE (RADAR) (METERS)
6. REPORT WHEN READY TO OBSERVE		16. ALTITUDE (RP) (14 + 15)

STEP 4: REPORT TO FDC

ALTITUDE (16) (HB)

; ATMY COMMAND; REQUEST SPLASH; READY TO OBSERVE

STEP 5: RECORDING AND COMPUTATION

	FROM B SCOPE		FROM TELESCOPE (HIGH BURST ONLY)			
			AZIMUTH DEVIATION (NOTE 3)		ELEVATION DEVIATION	
RD NO	RANGE	AZIMUTH	LEFT (–)	RIGHT (+)	BELOW (–)	ABOVE (+)
1	5120	600				
IF REQUIRED, ADJUST POINTING DATA AND CORRECT BLOCKS 7 AND 11 (NOTE 2)						
2	5010	609				
3	5100	602				
4	5050	605				
5	5090	603				
6	5020	610				
TOTAL	17. 30390	18. 3629	TOTAL LEFT (–)	TOTAL RIGHT (+)	TOTAL BELOW (–)	TOTAL ABOVE (+)

NOTE: AFTER SIX VALID ROUNDS REPORT "END OF MISSION" TO FDC	19. AZIMUTH DEVIATION = ALGEBRAIC TOTAL LEFT (–) AND RIGHT (+)	20. ELEVATION DEVIATION = ALGEBRAIC TOTAL BELOW (–) AND ABOVE (+)

23. REGISTRATION POINT RANGE (NEAREST 10 METERS)	24. AZIMUTH OF MPI (NEAREST 1 MIL)	21 ± 6 (19)	22. ± 6 (20)
5065 / 6 | 30390 (17)	604.8 = 605 / 6 | 3629 (18)	25. (21) (NEAREST 1 MIL)	27. (22) (NEAREST 1 MIL)
		26. (7)	28. (11)
		29. HB AZ (ALGEBRAICALLY ADD 25 AND 26)	30. HB ELEV (ALGEBRAICALLY ADD 27 AND 28)

STEP 6: FINAL REGISTRATION POINT ALTITUDE	STEP 7: REPORT TO FDC
31. RP RANGE (23) (IN THOUSANDS) 5.06	36. REPORT ON RADAR OBSERVED (CHECK APPLICABLE BOX) ☐ HB ☒ MPI
32. HB (ENTER VALUE BLOCK (30)) MPI (ENTER VALUE BLOCK (11)) +32	37. TIME OBSERVED 261835
	38. DIRECTION (MPI (24); HB (29)) (SEE NOTE 4) 605
33. VI (31 X 32) +162	39. DISTANCE (SEE NOTE 4) 5060
34. ALTITUDE RADAR 370	40. ALTITUDE (35) (SEE NOTE 4) 532
35. ALTITUDE RP (33 + 34) 532	41. GRID OF RP (NEAREST 10 METERS) 5180 4830

DA FORM 1 JUL 69 2888 REPLACES EDITION OF 1 JAN 65, WHICH WILL BE USED.

Figure 44. DA Form 2888 showing a completed MPI registration.

block 10 and records the sum, to the nearest mil, in block 11 as the pointing elevation.

(2) The *control unit operator*—

(*a*) Traverses the radar antenna to the vicinity of the pointing azimuth. To move the antenna to the approximate pointing azimuth, he positions the azimuth strobe in the center of the B-scope and rotates the antenna until the AZIMUTH counter on the computer panel indicates the approximate pointing azimuth.

(*b*) When directed by the recorder, places the antenna at the pointing elevation with the ELEVATION switch on the control-power supply panel.

(*c*) Prepares the computer and indicator panels by—

1. Placing the DETENT switch in the OFF position and locking the upper beam controls.

2. Placing the BEAM VIDEO selector switch in the LOWER position.

3. Placing the RANGE SHIFT switch in the OFF position.

(*d*) To orient the antenna in elevation during a night registration, when the screening crest cannot be observed through the telescope, elevates the antenna until the B-scope is free of all clutter. Then, he depresses the antenna until clutter starts to appear, but not so low that it appears in the area where the mean-point-of-impact registration will be conducted. He enters in block 11 on the registration form the elevation indicated on the ELEVATION-DEPRESSION counter on the radar trailer.

(3) The *recorder*—

(*a*) Enters all known data on DA Form 2888 and checks the computations performed by the radar plotter. DA Form 2888 completed by the recorder can be used to doublecheck the computations of the radar plotter.

(*b*) Directs the control unit operator to elevate the antenna until the center of the telescope is approximately 10 mils above the screening crest. When the antenna is oriented in elevation, he reads the elevation indicated on the elevation counter at the radar trailer. He then applies any elevation corrections determined during the elevation orientation check, reports the corrected elevation to the recorder, and enters this value on DA Form 2888.

e. Observation. The observation phase begins when the radar section reports READY TO OBSERVE and ends when the data from six usable rounds have been recorded. The duties of personnel during the observation phase are as follows:

(1) The *Control unit operator*—

(*a*) Watches the B-scope for the appearance of the echo as SPLASH is received for each round.

(*b*) Marks the point of entry where the round enters the beam.

(*c*) Marks the point of exit where the round leaves the beam (the echo disappears).

(*d*) Interpolates to find the point where the round passed through the center of the beam.

(*e*) Strobes the center point and announces the range and azimuth as indicated on the RANGE and AZIMUTH counters on the computer panel, to the radar plotter and the recorder.

(*f*) If the round is not observed, reports LOST.

(2) Both the radar plotter and the recorder should record in step 5 on DA Form 2888 the ranges and azimuths announced by the control unit operator.

f. Computation. In the computation phase, the duties of both the recorder and the radar plotter are the same as those for the high-burst registration, except that the azimuth read from the AZIMUTH counter on the computer panel is used in determining the azimuth to the mean point of impact, and the angle of elevation used in computing the altitude of the mean point of impact is the pointing elevation.

g. Reporting. The reporting phase in the mean-point-of-impact registration is similar to that in the high-burst registration.

Section II. RADAR ADJUSTMENT OF FIRE

43. General

a. The decision to fire or not to fire artillery and the choice of the method of attack on any target are made by the S3 of the firing unit. If the initial target location is accurate, first-round fire for effect may be delivered on the target. However, if the initial target location is doubtful, an observation agency must be used to adjust the fire on the target. Radar may be used as the observation agency during the adjustment phase of a fire mission. Normally, radar will be used as the observation agency only when no visual observation means is available and when one or both of the following conditions exist:

(1) No registration corrections are available.

(2) No survey exists and the target has been located by radar.

b. If the S3 decides to adjust on a target by using radar as the observation agency, the radar crew must be able to perform the adjustment rapidly and accurately. Speed, consistent with accuracy, is essential. The more time required for the adjustment, the more time the enemy will have to dig in or run.

44. Fire Adjustment Principles Pertinent to Radar

The goal of an adjustment is to move the burst of one round to the center of the target or target area. It is not necessary for the radar crew to know the location of the firing unit or the fire direction center. Nor is it necessary for the fire direction center to know the location of the radar. The adjustment is begun by firing one round into the area in the vicinity of the target. When the location of the burst of the adjusting round is determined in relation to the radar, the radar crew computes the relative distance and direction to move the burst to the target center. The first principle of fire adjustment that is pertinent to a radar adjustment is to move the burst to the target center. The second principle of adjustment is speed. Speed in adjustment is improved by training and by the use of standard terminology and procedures. The standard call for fire, the subsequent corrections, and the adjustment techniques must be correctly understood and used by the radar crew. The third principles of adjustment is to start the adjustment is to start the adjustment as close to the target as possible. This is done by using the best method available to determine the target location.

45. Target Location

To begin the adjustment as close to the target as possible, the most accurage means of target location must be used. The methods of target location available to the AN/MPQ–4A radar section are discussed below in the order of preference:

a. Grid Coordinates. The AN/MPQ–4A radar should be used to adjust fire on a point of known coordinates only when no visual observation means is available or when the target is in defilade and the firing unit has no registration corrections.

b. Polar Coordinates. Since polar coordinates can be read directly from the computer of the AN/MPQ–4A, their use is the next preferred method of target location. However, the FDC must know the location of the radar in order for this method to be used. Polar coordinates consist of the azimuth and distance to the target in relation to the radar.

c. Shift From a Known Point. If no map is available and the FDC does not know the radar location, the next preferred method is a shift from a known point. The point must be one which has been plotted on the radar chart and on the firing chart at the fire direction center. A shift from a known point consists of a lateral shift from the known point and a shift in range along the OT (observer-target) line. The shift is announced as FROM (known point), LEFT (RIGHT) (so much), ADD (DROP) (so much). The shift may be determined by computation or from the target grid on the radar chart.

d. Mark Center of Sector. Mark center of sector is a method of target location employed by radar. It is the fastest method that can be used to establish a known point when absolutely no survey control exists. In this method, the radar is pointed in the general direction of the target. A round is fired from a weapon to the center of the target area. The radar locates the point of impact of the projectile, and that point is plotted on the radar chart as a point of known location. The point can then be used for radar adjustment of fire on future target locations.

Note. In order to achieve surprise, the radar section may decide not to adjust on the target but to adjust on a nearby point. This nearby point, the auxiliary adjusting point, must be far enough away from the target that the real purpose of the adjustment is obscured. At the same time, the auxiliary adjusting point selected must be one which will permit determination of an accurate shift to the target. When the adjustment on the auxiliary adjusting point is complete, the fire is shifted to the target.

46. Call for Fire

a. When radar is used to adjust fire, the radar section must determine and transmit the call for fire and the subsequent corrections to the fire direction center. The call for fire is transmitted in a standard message format, using standard terminology, and contains the information required by the FDC for the preparation of fire commands. The information is transmitted in the order in which it will be use in the fire direction center. Subsequent corrections are transmitted to obtain changes in the elements of the call for fire necessary to move the bursts to the target center.

b. The call for fire contains six elements. These elements are listed in (1) through (6) below in

the order in which they are used. For a detailed explanation of each element, see FM 6–40.

(1) Observer identification.

(2) Warning order.

(3) Location of target.

(4) Description of target.

(5) Method of engagement.

(6) Method of fire and control.

c. The inherent characteristics of the AN/MPQ–4A radar require that some elements of the call for fire include information not normally included by a ground observer. For example, since the AN/MPQ–4A can more accurately locate the point of origin or burst of a single projectile fired at a high angle of elevation, the call for fire will include the terms ONE GUN and HIGH ANGLE in the method of engagement element. Also, the radar section will request that the FDC send a splash warning. This warning, SPLASH, is sent 5 seconds before the round is due to burst. The splash warning will not be sent unless it is requested; therefore, when it is desired, the call for fire must include the term REQUEST SPLASH. When the radar section wishes to control the time of firing, AT MY COMMAND is included in the method of fire and control element.

d. An example of a complete call for fire, using the correct communication procedures and prowords, is as follows:

Radar: BAR BELL 18, THIS IS SPLIT BEAM 14, FIRE MISSION, OVER.

FDC: SPLIT BEAM 14, THIS IS BAR BELL 18, FIRE MISSION, OUT.

Radar: GRID 273337, DIRECTION 6400, OVER.

FDC: GRID 273337, DIRECTION 6400, OUT.

Radar: MORTAR FIRING, ONE GUN, HIGH ANGLE, REQUEST SPLASH, VT IN EFFECT, AT MY COMMAND, ADJUST FIRE, OVER.

FDC: MORTAR FIRING, ONE GUN, HIGH ANGLE, REQUEST SPLASH, VT IN EFFECT, AT MY COMMAND, ADJUST FIRE, OUT.

47. Message to Observer

a. After the call for fire has been received and a decision to fire has been made, the fire direction officer issures a fire order. This fire order consists of the necessary commands for the FDC to start the production of firing data. Certain elements of the fire order are extracted by a computer in the FDC and sent to the radar section as a message to observer. This message to observer always contains four elements and any modification to the radar section's call for fire. The elements are as follows:

(1) *Batteries to fire for effect.* The first element informs the radar section which firing battery (batteries) will fire for effect.

(2) *Adjusting battery.* The second element informs the radar section which battery will conduct the adjustment.

(3) *Rounds in fire for effect.* The third element informs the radar section of the number of rounds that will be fired by each tube during fire for effect.

(4) *Target number.* The fourth element is the designation assigned to the target.

(5) *Modification.* A modification is any change to any element in the radar section's call for fire.

b. As an example, the call for fire requested shell high explosive and fuze variable time. However, the S3 decided that shell white phosphorus, fuze quick, would be used. The message to observer sent to the radar section is:

FDC: BATTALION, BRAVO, WP, ONE ROUND, TARGET RQ5020, OVER.

Radar: BATTALION, BRAVO, WP, ONE ROUND, TARGET RQ5020, OUT.

48. Radar Consideration

a. For adjustments, as for any other mission which the radar may be assigned, the site should be selected so that the angle of elevation to the screening crest is at least 15 mils but not more than 40 mils. The radar should be emplaced, leveled, collimated, oriented by the best means available, and range calibrated, and the accuracy of the computer should be verified.

b. A radar chart may be used in conducting a radar adjustment. If the radar location cannot be determined by survey or by map inspection, a grid intersection is selected as the radar position and is assigned arbitrary coordinates and altitude. The shift necessary to move the burst to the target may be determined from the target grid or may be computed. See FM 6–40 for a discussion of the target grid.

49. Subsequent Corrections

After the first burst has been located by the radar, the radar section transmits subsequent correc-

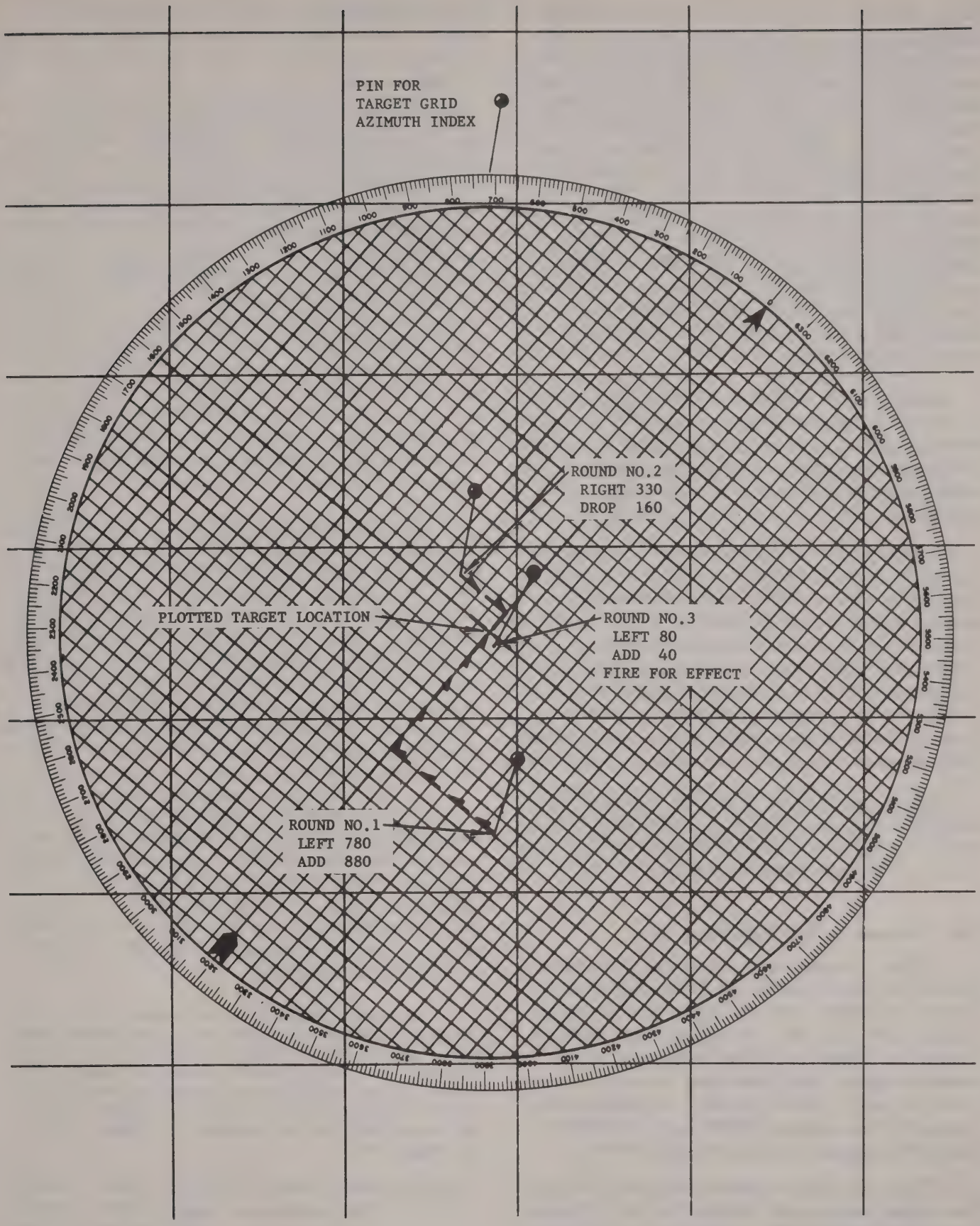

Figure 45. Use of target grid for determining radar fire adjustment corrections.

tions until the fire mission is completed. These corrections include appropriate changes to elements previously transmitted and the necessary corrections for deviation and range. A subsequent correction includes either a correction for deviation or range, or both, or the term REPEAT in which case no subsequent corrections are made. The term REPEAT is also used to indicate that the observer desires to repeat FIRE FOR EFFECT with or without corrections to any of the elements, i.e., ADD 50, REPEAT. Any other element of the call for fire for which a change or correction is not desired is omitted in the subsequent correction. The elements of subsequent corrections are discussed below in the order in which they are transmitted:

a. Deviation Correction. The radar plotter measures the distance that the round hit to the left or right of the radar-target (RT) line and announces the correction in meters necessary to move the round to the line. The deviation correction is announced to the nearest 10 meters.

b. Adjustment for Range. When the burst is moved to the radar-target line and is still short of the target, the correction is ADD followed by the number of meters, to the nearest 10 meters, required to move the rounds to the target. If the round is beyond the target when it is moved to the radar-target line, the correction is DROP followed by the number of meters, to the nearest 10 meters, required to move the rounds to the target. If no range change is required, that element is omitted.

c. Change in Control. When the radar crew desires to change the method of control from adjus fire to fire for effect, FIRE FOR EFFECT is sent as part of the subsequent correction.

50. Procedure for Adjusting Fire

a. When a target location has been determined, the call for fire is sent to the fire direction center The radar plotter plots the target location on the radar chart (fig. 45). In the normal situation, where the radar and firing units are not on a common survey grid, the radar chart is set up with the radar plotted at map inspected coordinates or, if no map is available, at a grid intersection with assumed coordinates and altitude.

b. The radar plotter places the target grid over the target location and orients the grid. The antenna is adjusted until it is pointing at the target. If a request has been made to mark the center of sector to locate the target, the antenna must b pointed in the general direction of the center of the sector.

c. When the battery is ready to fire the round, the message BATTERY IS READY is transmitted to the radar section. When the radar section has placed the correct pointing data on the radar set and is ready for the first round, the radar section sends the command FIRE to the guns. If the first round is not located by the radar, radar section send the command FIRE to the the radar section must quickly check the orientation of the radar set and verify that no error has been made in orientation or computation. When the radar section is again ready to observe, it transmits the command REPEAT to the fire direction center. The command REPEAT informs the fire direction center that the radar section did not obtain data for corrections and desires that another round be fired at the same location.

d. When the location of the burst has been determined, it is plotted on the radar chart. The distance that the round bursts to the left or right and over or short of the target (center of the target grid) is read directly from the target grid. The shift necessary to move the next burst to the target is sent to the fire direction center. These corrections are announced to the nearest 10 meters. The shift (or correction) RIGHT (LEFT) (so much), ADD (DROP) (so much) is understood to mean meters, even though the word "meters" is not expressed.

e. The adjustment is continued until a round bursts within 100 meters of the target (fig 45). As a general rule, the adjustment phase ends when a burst falls within 100 meters of the target in deviation and range. The radar section then requests final corrections and fire for effect from the fire direction center; for example: RIGHT 50, ADD 90, FIRE FOR EFFECT.

Note. Another method that may be used to determine deviation corrections and range shifts is to compare the grid coordinates of the burst, as read from the radar computer, with the grid coordinates of the target. This can be done by sending the radar-target direction to FDC as 6400 (ZERO) mils. The difference in easing (dE) is the lateral shift and the difference in nothing (dN) is the range shift.

Examples		
Grid coordinates of target	27300	33700
Grid coordinates of burst	27100	33500
	RIGHT 200	ADD 200

Section III. RADAR SURVEY

51. General

The likelihood of conflict in remote areas of the world places an increased requirement on the artillery to be able to conduct fire on a target with data obtained from inaccurate maps or even without maps. The artillery must be able to deliver rapid and accurate fire in remote areas, often without survey control or adequate time to complete an observed firing chart. The AN/MPQ–4A radar can be used to provide hasty survey control between the radar position and the artillery firing units by combining the procedures for marking a weapon location with those for observing a high-burst registration.

52. Conduct of a Radar Survey

a. Emplacement of the Radar. To conduct a survey mission, the radar should be emplaced near the center of the direct support battalion position area; however, it should not be closer than 1,000 meters to the weapons to be surveyed. (If a weapon is closer than 1,000 meters to the radar, a short survey traverse provides more reliable data.) The radar site should meet the normal positioning requirements for weapon location and radar gunnery applications. Assumed coordinates and altitude are set into the radar set computer.

b. Battery Coordinates. The coordinates of each battery center, relative to the radar, are determined by the radar section, using standard weapon location techniques. The radar beam is positioned over the battery being located. The base piece fires one round at high angle, and the location of the base piece is determined from data based on this one round.

c. Battery Altitude and Common Direction. The center battery fires a high-burst registration which can be observed from the radar site and from the battery center of each battery being provided survey. Each battery executive officer observes the high burst with an aiming circle set up over the battery center and laid parallel to the battery. The battery executives of the flank batteries measure and record the deflection and the vertical angle to the high burst. The executive officers compute the mean deflection and vertical angle to the high burst. The registration deflection effect is the difference between the registering executive officer's orienting deflection and his recorded mean deflection to the high burst. The correction is opposite the effect. The radar section provides the coordinates and altitude of the high burst, both of which are relative to the assumed altitude and coordinates set into the radar computer. The location of the high burst is plotted on the firing chart. The deflection indexes for the flank batteries are constructed at a value equal to the deflection correction modified by any error which occurred when the battery was initially laid. This error is determined by comparing the measured azimuth from each flank battery with the azimuth between the radar-provided battery location and the high-burst location. The center battery deflection index is constructed at the adjusted deflection to the high burst. The vertical angle measured from each battery is converted to a vertical interval, using the radar chart range, and applied to the high-burst altitude. This procedure provides the altitude of each battery which observed the high burst.

CHAPTER 6
MOVING TARGET DETECTION

53. General

The radar set AN/MPQ–4A has a limited capability for detecting and locating moving ground targets. Because of the large number of battlefield surveillance radars available within the division, the AN/MPQ–4A is seldom used in the moving target detection role. When the AN/MPQ–4A is used for moving target detection, a line of sight must exist between the radar set and the area of interest. Only the lower beam is used. The RANGE SELECTOR switch is placed in the 2500 M position with the EXPANDED SWEEP DELAY switch in the appropriate position to cover the area of interest. The pointing elevation is critical because of the narrow 14-mil beam.

54. Procedure

The preliminary procedures for preparing the radar set for moving target detection are identical with those for weapon location. Moving targets are detected as moving echoes on the B-scope. A moving target is located by strobing the echo in azimuth and range. Plotting the successive locations of a target on a contour map provides its direction and speed of travel. This information facilitates the delivery of artillery fire on the predicted location of the target.

CHAPTER 7
TACTICAL EMPLOYMENT AND POSITION REQUIREMENTS

55. General

The tactical employment and position requirements for the radar set AN/MPQ–4A depend on the tactical mission assigned to the radar section. Other technical and tactical factors that influence the operation of this equipment must also be considered. The suitability of a radar position can be determined only by the accomplishment of the assigned mission from that position.

56. Selection of Site

a. To insure complete coverage of the target area, coordination of the sectors of search for all radars is essential. The coordination of the sectors of search of all countermortar radars within the division is the responsibility of the division artillery S2. All tactical missions assigned to the radar section are determined by the direct support battalion commander. The battalion commander designates the general position area within which the radar section may select positions.

b. The primary considerations governing the selection of the radar position area are—

(1) The integration of the radar zone of search with the zones of other units, as directed by higher headquarters.

(2) The technical capabilities and limitations of the radar set.

c. The general position area should encompass an area large enough that the field artillery radar technician or the chief of section may select the actual radar site, based on the technical considerations affecting the operation of the radar. If possible, the radar position should be adjacent to the center battery of the battalion to simplify communications, facilitate survey and logistics, and enable the section to take advantage of any existing defensive perimeter. Depending on the mission, terrain, and situation, the radar position area should be located from 2,000 to 4,000 meters behind the forward edge of the battle area to give the radar section flexibility of action in both the offense and the defense.

d. The direct support battalion commander also designates the sector(s) of search for the radar, if it has not previously been designated by higher authority. This sector of search normally will coincide with the zone of action of the supported unit.

e. After the general position area has been designated, the radar technician or chief of section will make a reconnaissance before selecting the actual radar position. If time permits, this reconnaissance will be divided into two phases—a map reconnaissance and a ground reconnaissance.

(1) The map reconnaissance is made to determine, but is not limited to, the following:

(*a*) Possible sites available.

(*b*) Routes into and out of the area.

(*c*) Identifying landmarks.

(*d*) Locations of adjacent units.

(2) A ground reconnaissance is made after the map reconnaissance to facilitate occupation of the selected position. The ground reconnaissance is based on the tactical and technical considerations for the radar as modified by dictates of the particular mission, situation, and terrain. Since the time available for reconnaissance is generally limited, the reconnaissance must be organized so that it can be accomplished as completely as possible in the time allotted. It must be detailed enough to allow the radar technician or chief of section to make decisions and issue orders concerning—

(*a*) The exact location of the radar.

(*b*) The location of the radar operations center.

(*c*) The location of the generator.

(*d*) The location of the truck park.

(*e*) Routes into and out of the area.

(*f*) Searching and marking the area for mines.

(*g*) Local security, to include camouflage and defense against air and ground attack.

(*h*) The selection of alternate positions.

57. Tactical Considerations

The tactical considerations in selecting a radar site are similar to those considered in choosing a position for a field artillery firing battery. Normally, these considerations include communications, concealment, cover, routes of approach, security, and survey.

a. Communication. The communication requirements vary with the mission assigned to the radar section, but the site must permit the required communications to be established. Wire and/or radio are the normal means of communication for the radar section.

b. Concealment. In selecting a site for the radar, advantage must be taken of natural concealment, such as trees and shrubs.

c. Cover. The radar should be emplaced in defilade to the enemy to afford personnel and equipment all possible protection from hostile fire.

d. Routes of approach. The site selected for the radar should have more than one route of approach that will allow occupation of the site without being observed by the enemy. Road conditions, overhead clearances, bridges, and stream fords must be considered.

e. Security. If possible, the radar site should be selected within the defense perimeter of another unit to ease the local security requirements for the radar section.

f. Survey. The selection of a site near a firing battery or a known survey point facilitates the determination of the coordinates and altitude of the radar and the azimuth and elevation to a known point for orientation purposes.

58. Technical Considerations

a. As a defense against electronic countermeasures, the radar should be placed behind a screening crest (hill or ridge). The angle of elevation to the screening crest should not exceed 40 mils.

b. Other technical considerations that should be considered in selecting the radar site are the—

(1) Maximum range of the radar (10,000 meters).

(2) Sector coverage (445 mils).

59. Site Evaluation

a. After the radar site has been occupied, a radar site evaluation diagram must be prepared and sent to the battalion S2 at the earliest practical time to facilitate the preparation of the target acquisition capabilities chart. The radar is evaluated to determine its suitability for the assigned mission and to inform higher echelons of the capabilities and limitations of the radar set in that site.

b. A radar site evaluation diagram is a composite chart of both the screening crest profile and the clutter diagram, combined to depict all areas inadequately covered by the radar set. As additional time becomes available, the screening crest profile and clutter diagram are extended on both flanks of the sector of responsibility until the radar site evaluation diagram includes all hostile areas in which projectiles can be detected. The number of site evaluation charts prepared is established by the unit SOP.

c. The screening crest profile is constructed by the senior radar operator, assisted by one man who observes through the optical telescope. Initially, the antenna is positioned at zero mils elevation and alined on either the right or left azimuth limit of the suspect sector. The observer looks through the optical telescope and reads the angle of elevation to the screening crest at this point. This procedure is continued at 100-mil azimuth intervals throughout the assigned sector. If the screening crest is very irregular, the width of the intervals must be reduced. The elevation readings are plotted on the screening crest profile portion of the site evaluation diagram, and the profile is drawn.

d. The clutter diagram is constructed in the following manner:

(1) Turn the transmitter on. On the indicator panel, set the BEAM VIDEO selector switch in the LOWER position, and place the RANGE SELECTOR switch in the 10000 M position.

(2) Elevate the antenna 10 mils above the lowest angle of elevation to the screening crest within the assigned sector.

(3) If the width of the assigned sector is 445 mils or less, set the antenna on the azimuth of the center of sector. If the width of the assigned sector is greater than 445 mils, set the antenna on an azimuth 200 mils right of the left limit of the assigned sector and traverse the antenna to the right at several additional azimuth settings to cover the entire sector. In areas where the radar cannot observe, clutter (echoes from prominent terrain features) will appear on the B-scope.

(4) Using the LOWER BEAM RANGE and LOWER BEAM AZIMUTH controls, measure

the range and azimuth to several points around each patch of clutter.

(5) Plot these points on the clutter diagram portion of the site evaluation diagram and connect the points for each patch of clutter by a solid line. Continue this process at elevation increments of 15 mils until all clutter has disappeared from the B-scope. Color code the area for each elevation for ease of interpretation.

CHAPTER 8
SAFETY PRECAUTIONS

60. Principles

Using personnel will not perform maintenance or inspections on the radar equipment beyond those functions specifically authorized in this manual and in the appropriate technical manual.

61. Precautions

a. Dangerous voltage is used in the operation of the radar equipment. Personnel must exercise caution when working on or near the 440-volt plate and power supply circuits or on the 120-volt AC line connections. *Extremely high voltages* exist in the amounts specified in the following units:

Duplexer tube assembly	700 volts
Power supply PP–1588/MPQ–4A	700 volts
Indicator, azimuth and range IP–375/MPQ–4A	14,000 volts
Modulator and transmitter	26,000 volts

b. Do not refuel the power unit and do not handle or leave open gasoline containers in the vicinity of the radar set while the radar transmitter is on.

c. Radio-frequency energy transmitted by the radar set can produce damaging effects on body tissue.

(1) It can cause eye cataracts, headaches, testicular damage, and skin injury. Such harm can occur to personnel who are exposed to radiation of 10 milliwatts per square centimeter for a period of 10 minutes or longer.

(2) The power radiated by the radar AN/MPQ–4A is sufficient to cause the effects listed in (1) above when the individual is between the half-power points of the radar beam out to a distance of approximately 15 meters from the reflector. The effects will vary with the individual and length of time he is exposed.

(3) An observer is not exposed to the radar beam while he is observing through the optical telescope. There is a minimum clearance of 55 centimeters between the eyepiece of the optical telescope and the lower half point of the beam. There is a danger, however, that an operator standing erect by the optical telescope may expose his head to radiation above the safety level. During a high-burst registration, the observer should be cautioned to keep his head down near the eyepiece of the telescope.

d. Radioactive material is contained in type OB2 WA and type 6560 tubes. These tubes are potentially dangerous when broken. If handling personnel are cut by the broken tube, emergency medical attention is required. For specific instructions, see TB 750-237.

62. Electric Shock

Electric shock accidents can cause breathing to cease. A casualty may recover if artificial respiration is applied promptly and efficiently. The principles and procedures for the treatment of electric shock are described in FM 21–11.

CHAPTER 9
PROCEDURES FOR MINIMIZING THE EFFECTS OF JAMMING

63. Recognition of Jamming

The radar operator must learn to recognize the different forms of interference and to distinguish unintentional interference from deliberate interference caused by enemy jamming. Unintentional interference may result from the operation of nearby electrical equipment, or it may originate in the radar set itself. This interference will, at times, produce patterns on the radar scope similar to the patterns caused by enemy jamming. Interference caused by enemy jamming is indicated when an interference pattern remains on the scope after the interference from all friendly sources has been eliminated. When the operator has observed the interference and determined that it is the result of enemy jamming, the next step is to take all possible action (para 65-67) to minimize the effects of the jamming and to continue operation. If, because of enemy jamming, an untrained operator shuts down his set with the mistaken idea that the set is defective, he will be reacting just as the enemy wants him to. Through training and practice, the operator can learn to distinguish unintentional interference from the interference caused by enemy jamming and can take the necessary countermeasures.

64. Types of Jamming

Jamming is divided into two general categories—transmission jamming, which is produced by a transmitter radiating a modulated or an unmodulated radio-frequency signal, and reflective jamming, which is produced by reflecting devices and is intended to produce false targets or to obscure actual target signals on the radar scope.

a. Transmission Jamming. Transmission jamming usually has a directional characteristic; that is, the jamming indication normally is limited to a particular portion of the sector scanned by the radar being jammed. Depending on the type of transmission used, transmission jamming produces either strobe lines (extreme brightening of the sweep) or sector blanking (complete blanking of all indications) in the direction from which the jamming is being received. However, if the jamming signal is extremely strong, transmission jamming can completely saturate the radar scope, and the direction from which the jamming is being received cannot be determined. From the counter-counter-measure viewpoint, it is important to note the direction of the jamming indication, when the jamming does not have discernible directional characteristics, so that the jammer can be located and steps can be taken to reduce its effectiveness.

b. Reflective Jamming. Reflective jamming is produced by means other than active transmitters. Generally, reflective jamming is produced by reflecting items, such as rope, chaff, and straw. These reflecting items, usually in the form of various types, shapes, and sizes of metallic strips and metallic coated papers, are dropped from aircraft. The purpose of reflective jamming is to create false echoes or to produce large echoes, with the intention of shadowing or obscuring target signals from actual aircraft or missiles. Reflective jamming also is produced by window jamming devices, such as corner reflectors, metallic mesh, and stable, rotating or oscillating dipoles. These types of window jamming devices are intended to produce strong false echoes which will obscure the true target echoes or will "capture" the tracking radar by causing it to lock on the false echoes. False echo interference may be called deception instead of jamming. All window jamming devices operate on the same principle—that of reflecting the pulse transmitted from a radar set. Only by intensive training and experience can a radar operator learn to distinguish between true target echoes and echoes produced by window jamming devices.

65. Location of Jamming Source

When interference is received and it appears to the radar operator that it is deliberate enemy jamming, he should immediately report to his superior the type of jamming received and the direc-

tion from which it is received. The operator also should keep a record of the time, type, and direction of the jamming signal. Information from two or more radar sites may provide data to establish the exact location of the jammer and may determine its movement if the jamming originates from a moving source. These data can be used as a guide in resiting the radar equipment, or they may be used to produce fire direction data to place the site of the jammer under active fire with guns, missiles or aircraft. Jamming should be reported and recorded as long as the jamming indication is observed.

66. Procedure for Operation Against Transmission Jamming

After the type and direction of the jamming have been determined, the following procedures should be used by the AN/MPQ–4A radar operator to reduce the effectiveness of the jammer:

a. Gain Control. In continuous-wave jamming —a type of electronic jamming—a gain setting less than that used for normal operation is usually most effective. A reduced gain setting prevents overloading the receiver and allows the target echo to be seen through the jamming signal. The GAIN control should be varied over its entire range to find the setting at which the target echo is best seen. When continuous-wave jamming is strong enough to block the receiver completely, the GAIN control will not effectively reduce the jamming effects.

b. Local Oscillator. Varying the local oscillator tuning a small amount may help to reduce the effects of continuous-wave jamming if the jamming signal is confined to a narrow frequency band. Modulated jamming, however, usually produces a signal of sufficient bandwidth to make varying the local oscillator ineffective as an anti-jamming measure.

c. Siting. The AN/MPQ–4A radar is difficult to jam unless a *line-of-sight* orientation exists between the jammer and the radar. Therefore, it is important that the radar be located in defilade.

d. Antenna Elevation. If jamming occurs only when the jammer is in the main lobe of the radar, some relief may be obtained by increasing the vertical angle of the antenna. Even though the Δ time will be increased, the information obtained from the computer will still be of value.

67. Procedure for Operating Against Window Jamming

To counter window jamming, adjust the INTENSITY, FOCUS, and IF GAIN controls for maximum definition. Window jamming indications usually appear as many closely spaced targets (clutter). Good definition helps to separate the true target echoes from the jamming echoes and make it easier to follow the movement of the target indication through the random movement of the jamming echoes on the scope.

CHAPTER 10
DECONTAMINATION OF EQUIPMENT

68. General

a. This chapter discusses only briefly the subject of decontamination of equipment. In order to understand precisely how to perform these operations, the radar section should become thoroughly familiar with the procedures outlined in TM 3–220, TM 3–225, and FM 21–40.

b. Equipment which has been contaminated by chemical, biological, or radiological (CBR) agents must be decontaminated to reduce the hazard to personnel. Decontamination can be done by covering, removing, destroying or changing into harmless substances the contaminating material. Personnel performing CBR decontamination should wear the mask and their normal clothing buttoned at the neck and tied at the wrists and ankles with string (trousers bloused). For added protection, personnel may wear any other protective items that are available.

69. Chemical Decontamination

The best method for decontaminating radar equipment is to use hot air. The next best method is aeration or weathering. The metal parts exposed to blister and V-agents may be decontaminated with DS2, which is an excellent decontaminant for radar equipment. It is also readily available to the radar section. Electrical devices which contain electron tubes or other heat-producing elements are normally decontaminated by the heat given off during operation.

70. Biological Decontamination

A decontaminant for destroying or removing contamination should be effective against a variety of biological agents. Items currently available are natural decontaminants and chemical decontaminants. Most decontaminants and procedures for chemical decontamination are effective for biological decontamination. Natural decontamination by rain, wind, and sunlight will destroy most biological agents on the exterior of equipment within a day. Ethylene oxide or carbonide may be used to decontaminate the interior of equipment.

71. Radiological Decontamination

Decontaminants which have good cleansing characteristics are normally used for radiological decontamination, because the contaminants for fallout are usually finely divided particles which adhere closely to materials and tend to settle into pores and crevices. In most military situations, radiological contaminants are satisfactorily removed by flushing with water, by the use of steam and by brushing. The use of DS2 for chemical decontamination of equipment will also remove most radiological contamination. When speed is not an important factor, aging is the most desirable method, since it will make laborious decontamination work unnecessary.

CHAPTER 11
TRAINING

72. Purpose and Scope

The purpose of this chapter is to present the requirements for training the personnel of a radar section in the performance of their duties. It includes general information on the conduct of training.

73. Objectives

The objectives are to train radar crewmen rapidly in their individual duties and, through drill, to weld them into an effective, coordinated team that is capable of functioning efficiently and quickly in combat. Optimum efficiency is attained through frequent drills.

74. Conduct of Training

a. Training is conducted in accordance with the principles set forth in FM 21–5. The goal of training should be the attainment of the standards set forth in AR 611-201 and Army Subject Schedule 6–10.

b. Individual training is conducted by noncommissioned officers as much as practicable. Officers are responsible for preparing training plans, for conducting unit training, and for supervising and testing individual training.

c. Throughout training, the application of prior instruction to current training must be emphasized.

d. A record of the training received by each individual should be entered on a progress card maintained by each chief of section for each man in his section. This card should reflect each period of instruction attended by the individual, the tests taken, and remarks pertaining to his progress. Progress cards should be inspected frequently by the radar unit commander to make sure that they are being kept properly and to determine the status of training. *Requiring the chief of section to keep these records emphasizes his responibilty for his section.*

e. The necessity for developing leadership and initiative in noncommissioned officers must be emphasized constantly throughout training.

75. Standards to be Attained

Each member of a radar section must know the duties of the other members of the section. Section personnel must be able to perform efficiently in all positions. This goal is attained by rotating the duties during training. The qualification tests for AN/MPQ–4A radar crewmen are given in chapter 13.

76. Simulator, Radar Target Signal AN TPA–7

The simulator, radar target signal AN/TPA–7, is a transportable training set designed for use with the radar set AN/MQP–4A. This simulator generates electronic signals that duplicate actual projectile echoes on the radar B-scope. Electronic countermeasures (ECM) and atmospheric interference can also be simulated. To use this simulator, modification kit 40019264 must be applied to the radar set in accordance with the appropriate modification work order (MWO). The installation and operation of the simulator are described in TM 11–5840–287–12.

77. Training in Electronic Counter-Countermeasures

Radar trainer AN/ULT–T5 is a transportable, low-power radar transmitter designed primarily for use with any Ku-band radar set for training radar operators in antijamming techniques. The selected jamming signal is displayed on the scope of the radar simultaneously with the target signal. Instructions for installing and operating the radar trainer AN/ULT–T5 are contained in TM 11–6940–209–10.

CHAPTER 12
DESTRUCTION OF EQUIPMENT

78. General

a. Tactical situations may arise in which it will be necessary to abandon equipment in the combat zone. In such a situation all abandoned equipment must be destroyed to prevent its use by the enemy.

b. The destruction of equipment subject to capture or abandonment in the combat zone will be undertaken only upon authority delegated by a division or higher commander.

79. Principles

Each radar section will prepare a plan for destroying its equipment in order to reduce the time required if destruction becomes necessary. The principles to apply in preparing the plan are as follows:

a. Plans for destruction of equipment must be adequate, uniform, and easily carried out in the field.

b. Destruction must be as complete as the available time, equipment, and personnel will permit. Since complete destruction requires considerable time, *priorities* must be established so that the more essential parts will be destroyed first.

c. The same essential parts must be destroyed on all like units to prevent the enemy from constructing a complete unit from damaged ones.

d. Repair parts and accessories must be given the same priorities for destruction as the parts installed on the equipment.

80. Methods

To destroy equipment adequately and uniformly, all personnel of the unit must know the plan and priorities for destruction. For detailed information on the destruction of radar set AN/MPQ–4, see TM 11–5840–208–10; on the destruction of power unit PU–304C/MPQ–4, see TM 5–5264 or TM 5–6115–365–15; and on the destruction of the vehicle, see applicable vehicle manual.

CHAPTER 13

QUALIFICATION TESTS FOR AN/MPQ–4A RADAR SPECIALISTS

81. Purpose and Scope

This chapter describes the tests to be given in the qualification of AN/MPQ–4A radar specialists. Tests based on these outlines are designed to measure a radar crewman's skill in the emplacement and operation of the radar set AN/MPQ–4A. They are designed to determine the relative proficiency of an individual crewman in his performance of the duties of a radar specialist and are not intended for use in determining the relative proficiency of batteries or higher units. These tests are also designed to serve as an incentive for the individual radar crewman to expand his knowledge to cover all duties in the radar section, thereby increasing his value to the unit.

82. Preparation of Tests

The tests will be prepared under the direction of the battalion commander and should reflect the following:

a. Tests should be standardized so that the difference between the test scores of any two individuals will be a valid measurement of the differences in their skills.

b. Each radar crewman is a prospective candidate and copies of the tests should be available upon his request.

83. Organization of Tests

The qualification tests are organized to follow a logical sequence of events. They include the nomenclature of the radar set AN/MPQ–4A, selection of site and emplacement, operation of the radar set, evaluation of site, map reading and use of plotting equipment, weapon and impact location, and radar gunnery. The tests should be conducted in the sequence in which they are presented in this manual.

84. Administration of Tests

a. Because of differences in equipment, some modification may be necessary for the administration of the tests to some units. Any modification of the tests should be accompanied by a reevaluation of the weighting system.

b. The battery commander is responsible for the testing of personnel within his battery. Generally, the tests will be administered as follows:

(1) An officer, warrant officer, or enlisted man who is fully qualified and experienced in the subject covered by the tests will be detailed as the examiner to administer the tests.

(2) Each section of the qualification tests may be administered over a period of time, which should be standardized throughout the battalion.

(3) A single test, once started, will be conducted from start to finish without interruption.

(4) The candidate will receive no unauthorized assistance. Assistance will be furnished to the candidate as required for each test. If a candidate fails any test because of the examiner or any assistant, the test will be disregarded and the candidate will be given another test of the same nature.

(5) Times are not prescribed for each test because of the differing requirements in units and the varying effects of weather on the tests. However, the examiner should make appropriate cuts when excessive time is taken to complete a portion of a test. The responsible officer must decide what constitutes excessive time prior to the administration of the tests and according to the conditions existing at that time.

(6) The examiner will explain to the candidate the scope of the test and will indicate the men who will act as his assistants. The examiner will critique the candidate's performance at the completion of the test and turn the tentative score in to the battery commander. The battery commander will compute the final score and forward the test score to the battalion S3.

85. Qualification Scores

A total maximum score of 100 is possible on completion of the tests. The minimum scores required for qualification of expert, first class specialist, and second class specialist are as follows:

Individual classification	*Points*
Expert	90–100
First class specialist	80–89
Second class specialist	70–79

86. Outline of Tests

Paragraph	*Subject*	*Number of tests*	*Points each*	*Maximum credit*
87	Nomenclature of radar set AN/MPQ–4A	1	5	5
88	Selection of site and emplacement	1	8	8
89	Operation of radar set AN/MPQ–4A	10	—	36
	Test 1	(1)	5	(5)
	Tests 2 and 8	(1)	7	(14)
	Tests 3, 5, 6, and 9	(4)	2	(8)
	Test 4	(1)	4	(4)
	Test 7	(1)	3	(3)
	Test 10	(1)	2	(2)
90	Evaluation of site	1	7	7
91	Map reading and use of plotting equipment	1	6	6
92	Weapon and impact locations	3	6	6
93	Radar gunnery	2	7	14
	Totals	19	—	100

87. Nomenclature of Radar Set AN/MPQ–4A

a. Scope of Test. One test will be conducted in which the candidate will be required to locate, name, and/or state the purpose of various parts of the radar set AN/MPQ–4A.

b. Special Instructions. The nomenclature printed on the parts on which the candidate is to be questioned will be covered with masking tape or similar material.

c. Outline of Test.

Examiner commands—	Action of candidate
LOCATE, NAME, AND/OR STATE THE PURPOSE OF THE PARTS NAMED. (The examiner will select 20 items from the parts listed below):	Locates, names, and/or states the purpose of each part designated.
Antenna group OA–1258/MPQ–4A and all its components.	
Telescope M26A1 and mount, telescope.	
Control-indicator group and all its components.	
Dehydrator.	
Receiver-transmitter group and all its components.	
Power cable reel.	
Remote cable reel.	
Electrical equipment shelter and components.	
Control-indicator stand.	
Power cable.	
Remote control cable.	
Pedestal control cable.	

d. Penalties.

(1) Cut 0.25 point for each error in nomenclature or statement of purpose and for each failure to locate the specified part.

(2) If the total penalties exceed 3 points, no credit will be awarded.

e. Credit. Subject to the penalties assessed in *d* above, credit will be awarded as indicated in paragraph 86.

88. Selection of Site and Emplacement

a. Scope of Test. One test will be conducted in which the candidate will be required to select a radar site and explain how he would emplace the set.

b. Special Instructions.

(1) The examiner will prepare for the candidate's use a situation map of the area showing the following elements of an assumed situation:

(*a*) The location of established survey control in the area.

(*b*) The location of friendly units adjacent to the area in which the radar set is to be sited.

(*c*) The general area designated for selecting a site.

(*d*) The suspected area of enemy activity.

(2) When assessing penalties, the examiner must bear in mind that any selected position is a compromise.

(3) The following equipment should be furnished:

(*a*) Aiming circle.

(*b*) Binoculars.

(*c*) Map of area with all pertinent information.

(*d*) Plotting equipment.

(*e*) Compass.

(4) The mission of locating a mortar should be assigned to the candidate.

c. Outline of Test.

Examiner commands—	Action of candidate
SELECT A RADAR SITE AND EXPLAIN HOW YOU WOULD EMPLACE THE RADAR SET.	Selects a radar site within the designated area, as prescribed in paragraphs 55 through 59, and explains how he would emplace the set.

d. Penalties. Cut a maximum of —

(1) Four points for failure to select a position for which the terrain will provide electrical screening to minimize ground clutter and, at the same time, provide an acceptable screening angle of elevation (15 to 40 mils for radar gunnery).

(2) Two points for failure to select a position which provides ready access, cover, and concealment.

(3) One point for failure to consider the proximity of survey control.

(4) One point for failure to consider the proximity of friendly units.

(5) Four points for improper explanation of emplacement.

e. Credit. Subject to the penalties assessed in *d* above, credit will be awarded as indicated in paragraph 86.

89. Operation of Radar Set AN/MPQ–4A

a. Scope of Tests. Ten tests will be conducted in which the candidate will be required to operate the radar set AN/MPQ–4A.

b. Special Instructions. The examiner must ascertain that the radar set to be used by the candidate is in good working order prior to the start of the test and that the computer has been correctly alined.

c. Outline of Tests.

Test number	Examiner commands—	Action of candidate
1	PERFORM PRELIMINARY ADJUSTMENTS.	Performs the preliminary adjustments on the following equipment, as described in paragraphs 10 and 11: a. Receiver-transmitter group. b. Control-indicator group. c. Antenna group d. Interlock circuits. e. Vents.
2	PLACE THIS SET IN OPERATION.	Puts the set in operation by using the starting procedures, as outlined in paragraphs 12 and 13.
3	PERFORM THE FOLLOWING CHECKS AND ENTER THE RESULTS IN THE RADAR LOG. a. Ringtime check. b. AFC operation check. (The local oscillator must be properly tuned before the ringtime and AFC operation checks are performed.)	Performs the ringtime check and the AFC check, as outlined in paragraph 14.
4	RANGE CALIBRATE THIS SET BY USING THE RANGE MARKERS.	Performs the procedure for range calibration, as outlined in paragraph 18.
5	ORIENT THE ANTENNA IN AZIMUTH, USING THE ELECTRICAL METHOD, AND PERFORM THE AZIMUTH COLLIMATION CHECK. (The examiner will furnish the candidate a good electrical target at a known azimuth.)	Performs the required procedures, as described in paragraphs 15 and 16.
6	ORIENT THE ANTENNA, USING THE OPTICAL METHOD.	Performs the required action, as outlined in paragraph 16.
7	CHECK THE ALINEMENT OF THE ORIENTING TELESCOPE WITH THE ELEVATION DIALS.	Performs the elevation orientation check, as outlined in paragraph 17.
8	PERFORM THE COMPUTER ALINEMENT CHECK. (The computer must be properly alined prior to this test.)	Performs the computer alinement check, as described in paragraph 19.
9	SET THE ACTUAL RADAR LOCATION INTO THE COMPUTER.	Performs the required action, as outlined in paragraph 20.
10	PLACE THIS RADAR SET OUT OF OPERATION BY USING NORMAL STOPPING PROCEDURES.	Performs the normal stopping procedures, as described in paragraphs 21 and 22.

d. Penalties.

(1) *Test 1.* Cut 1 point for failure to —

(*a*) Set the AFC-MANUAL switch on the control-monitor panel to the AFC position.

(*b*) Set the three control-power supply controls to their proper positions. (Cut 1 point for each of the three settings.)

(*c*) Set the azimuth and range indicator controls to the proper positions. (Cut 1 point for each of the nine settings.)

(*d*) Check to make sure that the azimuth stowlock is out, the azimuth handwheel is all the way out, and the fenders are down. (No partial credit.)

(*e*) Close all interlocks and open all vents. (No partial credit.)

(2) *Test 2.* Cut 1 point for failure to —

(*a*) Check the power unit for proper voltage and frequency.

(*b*) Check the operation of the system blowers. (Cut 1 point for failure to check each of the three blowers.)

(*c*) Rotate the TEST METER SELECTOR switch and check the reading on both the control-power supply panel and the control-monitor panel.

(*d*) Verify the proper movement of the antenna in azimuth and elevation.

(*e*) Check the dehydrator for proper air pressure and dry air.

(*f*) Adjust the magnetron current to 22 ma after the transmitter has been turned on.

(*g*) Tune the local oscillator, if necessary.

(3) *Test 3.* Cut 2 points for failure to—

(*a*) Perform the ringtime check properly.

(*b*) Perform the AFC check properly.

(4) *Test 4.* Cut 0.5 point for failure to—

(*a*) Turn the RANGE SHIFT switch off.

(*b*) Set the range at 2,000 meters using the LOWER BEAM RANGE control.

(*c*) Set the RANGE SELECTOR switch to the 2500 M position and the EXPANDED SWEEP DELAY switch to position 1.

(*d*) Properly adjust and check the RANGE ZERO and RANGE SLOPE adjustments.

(5) *Test 5.* Cut 1 point for—

(*a*) Failure to use the LOWER BEAM AZIMUTH control to place the azimuth strobe over the target.

(*b*) Failure to adjust the IF GAIN control to reduce the size of the echo so that it may be easily bisected.

(*c*) Each error in collimation.

(6) *Test 6.* Cut 1 point for each error or failure to follow the proper procedure.

(7) *Test 7.* Cut 1 point for each failure to—

(*a*) Check the level of the radar set before centering the reticle on the checkpoint.

(*b*) Record errors greater than 1 mil.

(*c*) Know why the elevation orientation check is useful.

(8) *Test 8.* Cut 1 point for each failure to—

(*a*) Check the linearity between the antenna ELEVATION-DEPRESSION counter and the computer LOWER BEAM ELEVATION counter at seven elevations from —100 to +200 mils.

(*b*) Check the Δ AZIMUTH and LOWER BEAM AZIMUTH controls with the AZIMUTH counter and the range strobes.

(*c*) Check the Δ RANGE and LOWER BEAM RANGE controls with the RANGE counterand the range strobes.

(*d*) Check both the RADAR HEIGHTS counter and the weapon HEIGHT counter for proper operation.

(*e*) Check the RADAR LOCATION and WEAPON LOCATION counters by using the RADAR LOCATION EASTING and NORTHING switches.

(*f*) Check the linearity between the computer AZIMUTH counter and the movement of the azimuth strobe.

(*g*) Check the Δ TIME counter for proper operation.

(*h*) Know where the four computer accuracy check problems are located (in the computer compartment and in the logbook).

(*i*) Know the tolerances for the check results (not greater than 20 meters in easting or northing, with the sum of error not greater than 36 meters).

(*j*) Perform the required steps in sequence.

(9) *Test 9.* Cut 2 points for failure to know how to set the radar location into the computer.

(10) *Test 10.* Cut 2 points for failure to perform the normal stopping procedures.

e. Credit. Subject to the penalties assessed in *d* above, credit will be awarded as indicated in paragraph 86.

90. Evaluation of Site

a. Scope of test. One test will be conducted in

which the candidate will be required to evaluate the previously selected radar site by constructing the clutter and coverage diagrams.

b. Special Instructions.

(1) The following equipment will be made available to the candidate:

(*a*) One radar set AN/MPQ–4A.

(*b*) One radar site evaluation chart.

(2) The examiner will insure that the radar set is adjusted correctly and operating properly.

(3) Two assistants will be available to operate the set.

c. Outline of Test

Examiner commands—	Action of candidate
CONSTRUCT RADAR SITE EVALUATION CHART.	Constructs the radar site evaluation chart, as prescribed in paragraph 59.

d. Penalties. The candidate will be graded on the neatness, accuracy, and quality of his radar site evaluation chart. Cuts will be made accordingly.

e. Credit. Subject to the penalties assessed in *d* above, credit will be awarded as indicated in paragraph 86.

91. Map Reading and Use of Plotting Equipment

a. Scope of Test. One test will be conducted in which the candidate will be required to set up a grid sheet and plot the known friendly and enemy positions.

b. Special Instructions.

(1) The following equipment will be made available to the candidate:

(*a*) One mapboard.
(*b*) One grid sheet.
(*c*) One range deflection protractor.
(*d*) One coordinate scale.
(*e*) One plotting scale.
(*f*) One protractor.
(*g*) One 44H and one 6H pencil.
(*h*) Red, blue, and green hard lead pencils.
(*i*) Four map pins.
(*j*) One contour map of the area.

(2) The examiner will provide the candidate with the known friendly and enemy positions. The candidate should be given the grid coordinates and polar cordinates to plot. In at least one case, the height should be determined from a contour map. The radar azimuth indexes should be constructed.

c. Outline of Test.

Examiner commands—	Action of candidate
PLOT ALL KNOWN LOCATIONS ON GRID SHEET. (The locations and designations of adjacent units will be given to the candidate. Information may be in the form of polar coordinates or grid references. The candidate will have a map of the area for determining all additional information, such as heights of locations, labeling of lower left hand corner of grid sheet, etc.)	Constructs a grid sheet, as prescribed in FM 6–40, paragraphs 16–1 through 16–12, and FM 21–26, paragraphs 14, 15, 22, 23, 29, and 33.

d. Penalties.

(1) Cut 0.6 point for the incorrect—

(*a*) Labeling of the grid sheet.
(*b*) Establishment of the indexes.
(*c*) Labeling of a known location.
(*d*) Use or reading of the range-deflection protractor.
(*e*) Use or reading of the coordinate scale.
(*f*) Use or reading of the plotting scale.
(*g*) Use of map pins.
(*h*) Use of 4H or 6H pencil.
(*i*) Use of colored pencils.
(*j*) Use of height from the contour map.

(2) No credit will be allowed if penalties exceed 6 points.

e. Credit. Subject to the penalties assessed in *d* above, credit will be awarded as indicated in paragraph 86.

92. Weapon and Impact Locations

a. Scope of Tests. Three tests will be conducted in which the candidate will be required to act as the radar operator and the chart operator during detection and location.

b. Special Instructions.

(1) A radar set AN/MPQ–4A with the necessary equipment will be emplaced in a favorable position for detecting projectiles fired from a mortar and for locating the weapon and impact locations.

(2) A qualified operator will be made available to assist in operating the set.

(3) The examiner will make the necessary arrangements to provide the mortar with sufficient ammunition to conduct the tests. He will establish communication between the weapon and the radar site.

c. Outline of tests.

Test number	Examiner commands—	Action of candidate
1	SCAN ASSIGNED SECTOR FOR PROJECTILES. (Examiner will have a maximum of five rounds fired at approximately 1 minute intervals.)	Scans the assigned sector, detects the projectiles, and performs the procedures outlined in paragraphs 26 and 27.
2	COMPUTE THE WEAPON LOCATION.	Computes the weapon location, as prescribed in paragraphs 28 29.
3	COMPUTE THE IMPACT AREA OF THIS ROUND.	Computes the impact area, as prescribed in paragraph 33.

d. Penalties. Cuts will be made as follows:

(1) *Test 1.* For failure to—

(*a*) Adjust the radar so that it scans the proper sector in azimuth, cut 4 points.

(*b*) Set the elevation about 10 mils above the highest point of the screening crest in the sector, cut 2 points.

(*c*) Detect the projectile echo on the ascending leg of the trajectory, cut 1 point for each projectile echo missed.

(2) *Test 2.* For failure to—

(*a*) Strobe the echoes in proper sequence, cut 1 point.

(*b*) Place the DETENT switch in DETENT RELEASE position, cut 2 points.

(*c*) Use the TIMER switch properly, cut 1 point.

(*d*) Set the Δ TIME into the computer, cut 3 points.

(*e*) Plot the location on the map to determine the altitude, cut 2 points.

(*f*) Insert the altitude into the computer if the difference exceeds 20 meters, cut 3 points.

(*g*) Place the Δ RANGE and Δ AZIMUTH controls in detent after the final location has been made, cut 1 point.

(3) *Test 3.* For failure to—

(*a*) Aline the antenna on the proper azimuth for impact location, cut 4 points.

(*b*) Strobe the lower beam echo before the upper beam echo, cut 4 points.

(*c*) Use the Δ TIME, cut 2 points.

(*d*) Plot the location on the map and determine the difference in altitude, cut 2 points.

(*e*) Place the Δ RANGE and Δ AZIMUTH controls in detent after the final location has been made, cut 1 point.

e. Credit. Subject to the penalties assessed in *d* above, credit will be awarded as indicated in paragraph 86.

93. Radar Gunnery

a. Scope of Tests. Two tests will be conducted in which the candidate will be required to determine the grid or polar coordinates and the altitudes of a high-burst and a mean-point-of-impact registration.

b. Special Instructions.

(1) The following equipment will be made available to the candidate:

(*a*) Two DA Forms 2888 for use with the AN/MPQ–4A radar set.

(*b*) One sketch of the reticle in the orienting telescope with six rounds representing high bursts placed at random around the center of the reticle. The range deviation for each round will be listed adjacent to the reticle sketch.

(*c*) One grid sheet.

(*d*) Necessary plotting equipment.

(2) During the test on high-burst registration, the candidate will use one DA Form 2888. He will determine and record the pointing data and the deviations indicated on the sketch of the telescope reticle. He will then compute the average range, elevation, and azimuth to the center of burst and determine the grid coordinates and altitude of the high-burst location.

(3) During the test on mean-point-of-impact registration, the candidate will use one DA Form 2888. He will determine and record the pointing data. The range and azimuth for each round will be given to the candidate, and he will enter this information on the form. He will then compute the average range and azimuth to the center of burst and determine the grid coordinates and altitude of the mean-point-of-impact registration point.

(4) The examiner will use the standard procedures, as shown in paragraphs 37 and 40, initiate tests 1 and 2 for the high-burst and the mean-point-of-impact registration.

c. Outline of Tests.

Test number	Examiner commands—	Action of candidate
1 *a.*	CONDUCT RADAR-OBSERVED HIGH-BURST REGISTRATION. REPORT WHEN READY.	Conducts radar-observed high-burst registration as prescribed in

Test number	Examiner commands—	Action of candidate
	(The following information will be made available to the candidate: location of the radar, screening crest angle, field correction, unit to fire, high-burst location, and minimum altitude.)	paragraphs 37 through 39.
	b. DETERMINE THE GRID COORDINATES AND ALTITUDE TO THE HIGH-BURST LOCATION AND RECORD THE DATA IN STEP SEVEN OF DA FORM 2888.	
2	*a.* CONDUCT RADAR-OBSERVED MEAN-POINT-OF-IMPACT REGISTRATION. REPORT WHEN READY. (The following information will be made available to the candidate: unit to fire, location of mean-point-of-impact registration point, location of the radar, and the screening crest angle.)	Conduct radar-observed mean-point-of-impact registration as outlined in paragraphs 40 through 42.
	b. DETERMINE THE GRID COORDINATES AND ALTITUDE TO THE MEAN-POINT-OF- IMPACT REGISTRATION POINT AND RECORD THE DATA IN STEP SEVEN OF DA FORM 2888.	

d. Penalties. Cuts will be made as follows:

(1) For each mistake in determining the pointing data, cut 2 points.

(2) For each mistake in filling in the form, cut 1 point.

(3) For inability to determine the range and azimuth to the registration point or high-burst location or for inability to determine the data to be sent to the fire direction center, proportional cuts up to 7 points may be made commensurate with the candidate's knowledge.

e. Credit. Subject to the penalties assessed in *d* above, credit will be awarded as indicated in paragraph 86.

APPENDIX

REFERENCES

1. Field Manual (FM)

5–15	Field Fortifications.
5–20	Camouflage.
5–25	Explosives and Demolitions.
6–2	Artillery Survey.
6–20–1	Field Artillery Tactics.
6–20–2	Field Artillery Techniques.
6–40	Field Artillery Cannon Gunnery.
6–121	Field Artillery Target Acquisition.
6–140	Field Artillery Cannon Battalions and Batteries.
21–5	Military Training Management.
21–11	First Aid for Soldiers.
21–26	Map Reading.
21–30	Military Symbols.
21–40	Chemical, Biological and Nuclear Defense.
21–60	Visual Signals.
22–5	Drill and Ceremonies.
55–35	Motor Transport Operations and Motor Transport Units.

2. Technical Manuals (TM)

3–220	Chemical, Biological, and Radiological (CBR) Decontamination.
5–2805–204–14	*Organizations, DS and GS Maintenance Manual: Engine, Gasoline, Military Standard Models: . . .
5–2805–204–24P	*Organizational, DS and GS Maintenance Repair Parts and Special Tool Lists: Engine, Gasoline, Military Standard Models: . . .
5–5264	Generator Set, Electric, Portable, Gasoline-Driven, Tubular Steel Frame Mounting, 12 ½-KW, 120/208-Volt, 400-Cycle, Single or 3-Phase, and 2½-KW, 28-Volt, D.C. Hollingworth Model PU–107A/U.
5–6115–365–15	*Organizational, DS, GS, and Depot Maintenance Manual, Including Repair Parts Generator Sets, Gasoline and Diesel Engine Driven, Trailer Mounted: . . .
5–6115–450–15	Operator, Organizational, DS, GS, and Depot Maintenance Manual: Generator Set, Gaso-

Note. Refer to DA Pamphlet 310–4 for complete listing of all items covered in this manual.

	line Engine: 10-KW, AC, 120/240–V. Single Phase; 120/208–V, 3-Phase, 400-Hertz, Skid-Mounted (Less Engine) (Military Design Model HF 10.0–MD).
9–1375–200	Demolition Materials.
9–1900	Ammunition, General.
9–2330–213–14	*Organizational DS and GS Maintenance Manual: Chassis Trailer: 1½-Ton, 2-Wheel . . . M103A3 . . . Trailer, Cargo: 1½-Ton, 2-Wheel . . . M105A2 . . .
9–2330–234–15	Operator, Organizational, Field and Depot Maintenance Manual: Chassis, Trailer: 2½-Ton, 2-Wheel, M454 (2330–703–5847).
9–2330–234–24P	Organizational, Direct and General Support Maintenance Repair Parts and Special Tools List for: Chassis, Trailer: 2½-Ton, 2-Wheel, M454 (2330–709–5847).
11–5840–208–10	Operator's Manual: Radar Set AN/MPQ–4A.
11–5840–208–20	Organizational Maintenance Manual: Radar Set AN/MPQ–4A.
11–5840–208–25P	Organizational, DS, GS, and Depot Maintenance Repair Parts and Special Tool Lists: Radar Set AN/MPQ–4A.
11–5840–208–30	DS Maintenance Manual: Radar Set AN/MPQ–4A.
11–5840–287–12	Operator and Organizational Maintenance Manual: Simulator, Radar Target Signal AN/TPA–7.
11–6940–209–10	Operator's Manual, Radar Trainer AN/ULT–T5.
38–750	Army Equipment Record Procedures.
55–450–11	Air Transportation of Supplies and Equipment: Helicopter External Load Rigged with Aerial Delivery Equipment.

3. Table of Organization and Equipment (TOE)

6–116	Headquarters, Headquarters and Service Battery, Field Artillery Battalion, 105–mm, Towed, Separate Light Infantry Battalion.
6–156	Headquarters Headquarters and Service Battery, Field Artillery Battalion, 105–mm, Infantry Division.
6–186	Headquarters, Headquarters and Service Battery, Field Artillery Battalion, 105-mm, Towed, Separate Infantry Brigade.
6–216	Headquarters, Headquarters and Service Battery, Field Artillery Battalion, 105-mm, Towed, Ariborne Division or Headquarters, and Service Battery, Field Artillery Battalion, 105-mm, Towed, Separate Air-Brigade.
6–346	Headquarters, Headquarters and Service Battery, Field Artillery Battalion, 105-mm, Self-Propelled, Armored Division; or Headquarters, Headquarters and Service Battery, Field Artillery Battalion, 105-mm,

	Self-Propelled, Infantry Division (Mechanized).
6–366	Headquarters and Headquarters Battery, Field Artillery Battalion, 155-mm, Self-Propelled, Armored Division or Headquarters and Headquarters Battery, Field Artillery Battalion, 155-mm, Self-Propelled, Infantry Division (Mechanized).
6–376	Headquarters and Headquarters Battery, Field Artillery Battalion, 155-mm, Self-Propelled, Separate Armored Brigade or Headquarters and Headquarters Battery, Field Artillery Battalion, 155-mm, Self-Propelled, Separate Infantry Brigade (Mechanized).
6–386	Headquarters, Headquarters and Service Battery, Field Artillery Battalion, 105-mm, Self-propelled, Separate Armored Brigade; or Headquarters, Headquarters and Service Battery, Field Artillery Battalion, 105-mm, Self-Propelled, Separate Infantry Brigade (Mechanized).

4. Miscellaneous

AR 310–25	Dictionary of United States Army Terms.
AR 611–201	Enlisted Military Occupational Specialties.
AR 750–5	Organization Policies, and Responsibilities for Maintenance Operation.
ASubjScd 6–10	Field Artillery Radar Operations.
ATP 6–100	Field Artillery Cannon Units.
ATT 6–155	Field Artillery Battalion, Light or Medium, Towed or Self-Propelled.
DA Form 2888	Radar Observed High-Burst or Mean-Point-of-Impact (Datum Plane) Registration, AN/MPQ–4A.
DA Form 2407	Maintenance Request.
DA Pam 108–1	Index of Army Films, Transparencies, GTA Charts, and Recordings.
DA Pam 310-series	Index of Military Publications.
LO 5–5264	Generator Set, Electric, Portable, Gasoline-Driven, Tubular Steel Frame Mounting, 12½-KW, 120/208-Volt, 400-Cycle, Single or 3-Phase and 2½-KW, 28-Volt, D.C. Hollingsworth Model PU–107A/U.
TB 150–237	Identification and Handling of Radioactive Items in the Army Supply System.
TF 6–3096	Countermortar Radar AN/MPQ–4A. (22 min).
TF 6–3185	Countermortar Radar AN/MPQ–4A, Preparation and Performance Checks. (26 min).

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By Order of the Secretary of the Army

W. C. WESTMORELAND,
General, United States Army,
Chief of Staff.

Official:
KENNETH G. WICKHAM,
Major General, United States Army,
The Adjutant General.

Distribution:

To be distributed in accordance with DA Form 12–11 for Radar Set, AN/MTQ–4A.

★ U. S. GOVERNMENT PRINTING OFFICE : 1969 356-419/20029